

Maria Vargas:

Good morning. Morning. Thank you. It's great to hear a good morning right back. I am delighted to see so many of you. I know there were lots of activities last night, so I appreciate so many of you joining us relatively early this morning for the second and final day, or third day of the Better Building Summit in 2022. Again, thank you all so much for being here. As a reminder, my name's Maria Vargas. I oversee the Better Buildings Initiative with an amazing team at DOE and some contractors for the Department of Energy. And it's our pleasure to have all of you with us today.

We've got a really great plenary for you this morning. We're going to be recognizing many of you in the room, most notably the organizations that hit their goal in the last year. And we're going to bring them up on stage and give them some recognition. But we're also going to do something which has been a best seller, if you will, for the summits over the past couple years. And that is we've asked three experts from our national labs, three different national labs, to come up and tell you – they get to do a presentation which isn't usually what they do, but that's what the Better Building Summit is about.

We ask them about we ask them to tell you one or two things that they are really excited about, they think you should be on the watch for, and are open to taking all of your questions. So as all of you know, the summit is designed to be interactive. That includes plenary sessions. So as a reminder for those of you who are here yesterday, you have index cards on your table. Those are meant for any questions that you have. So as you hear from the lab speakers as part of the plenary this morning, please do write down your questions, and then folks will be traveling around to pick those up because we want to hear from you and make sure that you're able to ask any questions you want of the experts that we have with us today.

So speaking of “with us today”, we had hoped to have the Undersecretary of Energy, Dr. Geri Richmond with us in person. She got called on travel by the White House, but she wanted to make sure that she was here in spirit. And so she sent some remarks. So if I can just play some quick remarks from Dr. Geri Richmond. She is the undersecretary at the Department of Energy for science and innovation.

And so in her role, she oversees the Office of Science, which is the nation's largest federal sponsor of basic research in the physical sciences, DOE's applied research and development area of nuclear fossil renewable energy and energy system integrity, and that the

DOE national labs and their facilities. So with that, I'm pleased to introduce just a couple remarks from Dr. Geri Richmond.

Dr. Geri Richmond: Thank you, Maria. And good morning, everyone. I'm Geri Richmond, Undersecretary of Science and Innovation at the US Department of Energy. I wish I could be with you in person, but I wanted to pass along my gratitude for your partnership and your commitments to improve how we use energy in this country. Today, more than 350 organizations are partnering with DOE to set portfolio-wide energy reduction goals. Thanks to all those partnering in the Better Buildings Initiative.

Collectively, we've saved 2.5 quadrillion BTU of energy equivalents to more than 150 million tons of carbon dioxide avoided. That's as much carbon as nearly 20 million home's energy use for a year. And more than 15 billion dollars saved, money that goes back into our economy. You've also shared thousands of solutions so that others can learn from your work. And that helps all of us accelerate the pace of greater energy efficiency, the cornerstone of decarbonization efforts.

And the feedback you share was DOE through the Better Building Initiative helps my office and the Office of Science of the needs and the priorities of the marketplace. And this helps shape how we invest and research and create technical assistance. Your input has helped develop technology information suites designed to help the market understand and overcome technical barriers. From conduction losses and solar gains in windows, to advance refrigeration technology, these resources provide in depth insights into the latest technological advances.

As manufacturers the feedback you give us through the Better Plants Program and Challenge including through in-plant trainings, Technology Days at the national labs, and the work currently underway through the industrial technology validation pilot has helped us better understand the real world challenges of driving change across your sector. And I especially want to celebrate the work of our goal achievers here today. You committed to ambitious portfolio-wide energy and water reduction goals, and you met them. Congratulations and thank you.

Collectively, more than 90 Better Buildings Challenge partners have met an energy reduction goals, 13 have met a water reduction goal, and 27 financial allies have met a financing goal. This year we had 12 goal achievers who demonstrated what it meant to be market leaders. We've highlighted their work and the

achievements of many others in our annual progress report released yesterday, and we are also incredibly proud of everything that you have accomplished. Your success as an example to other organizations across the nation. Thank you for your leadership. Together, we're taking real action to meet the nation's climate goals. So Maria and Kelly, please pass on my congratulations. And thank you.

Maria Vargas:

How many of you learn something yesterday at least one thing you're going to take back to your organization to try and do different? Oh, I love that. Okay. Wait, keep those hands up because I want to figure out who doesn't have their hand up and I'm gonna come find you. *[Audience laughter]* I'm gonna come find you and tell you, like talk to you and make you connect you with the right folks that we can and make sure that you go back. Well, that's terrific. That's the goal of the summit.

I was thinking about that last night. A couple people at the reception told me they had learned a couple things and it made me very happy to hear because that's the goal. We want to go home having talked to organizations like yours, but also organizations very different. That's really what this is about, the cross-fertilization of learning among leaders so that you all can take lessons learned from others and go back to your organization to truly accelerate, drive, continue the amazing work you're doing to drive energy efficiency and emissions reductions in your organization.

So I talked to someone this morning who told me that the summit was filling their bucket. I won't rat him out. I'm winking over here. And that's terrific because it really is nice, and we're glad you're here to be among a group of people and organizations that have the same priorities, goals, and hopes that you all do for making our country better, whether it's through energy efficiency or energy efficiency and decarbonization. So thank you again all for being here. So now I'm excited to start this morning's recognition by recognizing those organizations that achieved their goal. These are the 2022 goal achievers.

So it's my pleasure to invite on the stage with me, my colleague Carolyn Snyder. Carolyn is the Deputy Assistant Secretary for Energy Efficiency at the US Department of Energy. She and I both work in the Office of Energy Efficiency and Renewable Energy. And the way it's gonna work today we have 12 organizations who have achieved their goals in the past year. We have five that are with us today. And we are going to invite them up on stage to

receive their crystal. They'll take a picture with Carolyn. You guys will all be cheerleaders for encouraging and celebrating their great work. And then they will set off the stage and we'll recognize another group of goal achievers from previous years.

But without further adolescent, let's start. So the first organization we want to highlight is the city of Knoxville, Tennessee. Knoxville, Tennessee. Awesome. So city of Knoxville. *[Audience applause]* You guys are so good with your applause, but now I have to read really fast. So Knoxville, Tennessee we are excited because they met their *[crosstalk]* What's that? Oh, we're good. Okay. So here's what you need to know about Knoxville. They achieved a 26 percent reduction in energy intensity across 3.3 million square feet.

Through Knoxville's Energy and Sustainability Workplan, the city has mapped out policies and programs to reduce excess energy consumption and standardize environmentally sustainable best practices. Its aggressive drive towards energy efficiency as a result of focusing on conservation, emphasizing awareness of low cost opportunities for savings. Additionally, the city works to drive down their building footprint through performance contracts and close collaboration with the Knoxville Utilities Board to support the largest solar investment in the TVA territory. With us today is Grace Levin, sustainability coordinator for the city of Knoxville. Thanks, Grace. *[Audience applause]*

Okay. Now let me read and then applaud. So next one, now we're gonna recognize Life Time. Life Time, come on up, has improved energy performance by 38 percent by upgrading HVAC controls, HVAC equipment and controls, implementing lighting retrofits, and undergoing a full commissioning process throughout its building portfolio of 16 million square feet. Life Time is the only chain of athletic country clubs with over 150 locations nationwide to partner with us in the Better Buildings Challenge.

They demonstrate some unique energy efficiency measures such as optimization solutions that cut down peak demand and runtimes of steam rooms in Life Time's clubs. Peter Isabell, the director of energy management sustainability is with us here today to accept the award. Congratulations. *[Audience applause]* So if you want to go work out, go to Life Time. That's the goal.

Okay. Next, we recognize Minneapolis Public Housing Authority. Minneapolis Public Housing Authority has achieved a 20 percent reduction in energy efficiency across 3.4 million square feet two

years ahead of schedule. Minneapolis Housing Authority has committed over 4,500 multifamily housing units to the challenge, and has achieved energy savings from extensive energy performance contracts that included LED lighting upgrades, Energy Star-qualified appliance replacements, installation due to re-roofing, and a robust preventive maintenance program for HVAC equipment. With us today is Mary Boler, managing director of Low Income Public Housing at the Minneapolis Public Housing Authority. *[Audience applause]*

As many of you know, we work with organizations not just on energy, but also water and waste goals. So Wendy's is the next award winner. And they have achieved their energy goal. And the cool thing about Wendy's is that they've invited their franchisees to also work with their corporate headquarters. And so today we're gonna recognize Wendy's company, which has more than 6,900 franchisees and company-operated restaurants, is the first company to have its franchisees also join the Better Buildings Challenge.

Wendy's has achieved a 25 percent reduction in water across 1.2 million square feet of company-owned properties by installing automated dishwashing equipment and piloting smart irrigation systems. We're also going to give an award and recognize, Thomas is going to sort of represent both organizations today, Wendium of Florida, they are very large franchisee for Wendy's, and they've achieved a 31 percent reduction in water use across over 18,000 square feet.

And this franchisee has become the first to achieve both their water and energy goals under the Better Buildings Challenge. They achieved their goal by installing wear wash machinery and performing consistent preventive maintenance and monitoring for leaks. With us today to be recognized for both of those groups is Thomas Grant from the Wendy's company. Thanks, Thomas. *[Audience applause]*

And last but certainly not least is Will County, Illinois. Thank you. Come on up. Briana Moore is here from Will County. And we are recognized in Will County for a 23 percent reduction in energy intensity across over a million square feet. Will County improved energy performance in its portfolio by completely energy efficient retrofits including lighting replacements, HVAC improvements, building envelope upgrades, and operating system adjustments. Its energy efficiency and conservation plans and progress reports guided those efforts and will for more than ten years. With this

today is Briana Moore, energy and conservation specialist for Will County, Illinois. *[Audience applause]*

Okay. There were, as I mentioned, 12 goal achievers this year. So we're just going to do a quick shoutout for the other organizations that achieved their goal but weren't able to be with us here today. So you can see them on the screen. Bullitt County Public Schools, Fort Worth Independent School District, Jamaica Plains Neighborhood Development, Legrand, Washington D.C. Housing Authority, and Whole Foods Market. So if we can give all those guys a round of applause even though they're not here, that's awesome. *[Audience applause]*

So as many of you know, we've had an interesting last couple years. Over the last two years, our summit has been virtual so that's why it's so great to see everybody here today. But what we thought we would do is just bring up on the stage as a group the organizations from 2021 and 2020 that achieved their goals because they never really got the opportunity to do this. As someone who had a child who never walked across the stage for their commencement in college, we thought it was really important to bring folks here to be recognized.

So I'm gonna ask all these organizations, we're gonna take one group picture, I'm gonna ask all these organizations to come up to the stage if you will. We'll take one quick picture, move onto some other recognition, and then the lab panel. So if I can have Allumia, city of Orlando, Owens Corning, Steelcase...come on, people. I know you're in the room because I talked to you this morning. Okay. Great. That was the 2021 group.

The 2020 group was Bank of America, Cleveland Clinic, Mercy Housing, Michigan State University, Nuveen, Parkway School District, USAA, and the University of Utah. So if you guys would give these guys all a round of applause, it'd be great. *[Audience applause]*

[Group picture]

What a good looking group. Thank you guys and congratulations. *[Audience applause]* Okay. A couple more organizations, many of you in this room that we're gonna recognize. So next group, I just want to acknowledge is our inaugural group of Better Climate Challenge partners. Many of you in the room. We now have over 100 organizations working with us. We launched this – for those of you who are you here yesterday to hear both Secretary Grandholm

and National Climate Advisor Gina McCarthy talk about it, we have over 100 organizations.

This is really the federal platform to work voluntarily with the market with organizations which are willing to step up and reduce their greenhouse gas emissions scope one and scope two by at least 50 percent over ten years, share what they're doing, and without using offsets. So just a huge shoutout for those organizations working with us. We can't wait to work with them to figure out what's working because we know we have lots of different pathways to report on decarbonization, and we know that we know some of it, but we don't know all of it. And this is going to be a team effort so we really appreciate these organizations standing up.

Next group is the allies who are working with us in the Better Climate Challenge. These are organizations, typically NGOs, associations, important stakeholders that are going to work with us to make sure that the work we're doing, the solutions, the resources that we develop are made available and accessible to all the organizations they work with, and they're also going to be really important thought leadership partners with us in the challenge. So thank you to them.

The next group I wanna really give a shoutout to is those organizations, many of you in this room, who are working with us on the low carbon pilot. For years in the late – it doesn't matter. About five years ago, we started hearing from organizations – yeah, I can't do math this money. So a number of years ago, our partners, you all, started talking to us about we've done efficiency. We really believe that there is – there, we want to continue to work on decarbonizing our portfolio.

And we didn't know quite what we wanted to do, so we thought we would pilot an effort where we ask organizations to take two of their buildings, plants, multifamily housing properties, and work with us to understand really what it would take and to actually move ahead to decarbonize those buildings. And so this is the group of over 65 organizations that are working with us on the low carbon pilot.

And just a huge shoutout. I mean those folks really stepped up when we needed them to, to sort of help us figure this out, and their work, their thoughts, their feedback was quite pivotal in how we ended up structuring the better climate challenge. So just a huge shoutout for all of you working with us on the low carbon pilot. A couple other groups. I'm hoping that all of you are

beginning to see your on a couple of these slides. As I mentioned through the Better Buildings Initiative, remember a broad platform includes Better Plants, the Accelerators, Low Carbon Pilot, Better Climate Challenge. We also working with organizations who are interested in reducing their waste and water.

And so we've asked organizations who want to work with us to join a network working with us. And so this is the current folks that are working with us on the water savings network. And then the next slide you'll see is the waste savings network. If your name isn't on here, and you want to do that with us, we would love to have you. This is really a little bit more structured around convening and hearing best practices and ideas, as opposed to some of the more rigorous reporting we do through some of the other programs, not any less important because it really is important to attack those issues as well. And they all have energy implications, so we're delighted to be working with you.

Okay. Last couple slides I want to run through is that many of you. You know, when we ask you to set a portfolio-wide goal across your facilities and plants, and multi-family housing, there is a lot of work. Lots of organizations are very big. They're constantly changing. They're buying and selling assets. So we just want to give a shoutout. I know we have some goal achievers onstage, and those folks really were, and I appreciate your tremendous support for them this morning because they deserve it for all the work they did to reach their goal, but there are lots of partners, many of you who are on track. And we just want to celebrate what you're doing as well because you're on track working with us.

So we're just going to go through the different sectors. I hope you see your names on there. We're loving working with you and we look forward to continuing to do that. You can see the state and local group. And keep going. There we go. Multi-family. Industrial partners. There are a lot of you doing some great work, so a shoutout to all of you. So I'm just going to pause there and say can you guys give yourselves – I hope you saw your names on those slides, so. *[Audience applause]*

Okay. Two more cohorts of folks that we want to recognize today. The next group is the Green Lease Leaders winners. So in 2014, DOE partnered with IMT, Institute for Market Transformation to develop the Green Lease Leaders Awards Program. This is really a recognition platform for the industry that really wants and is partnering with forward-thinking real estate companies who are effectively modernizing their leases. Right? Because one of the

questions we hear a lot a lot, one of the barriers is, well, I can't do that because I got tenants, and the tenants don't want to engage on this stuff. So sorry, can't do anything.

Well, the Green Lease Leaders are folks that said, "No, no, we actually can do something about that. We can change how we structure our lease to involve the tenants, get them on board, and actively work with them to reduce energy efficiency – to improve energy efficiency in their space." So this year, we're pleased to recognize 53 organizations across sectors including commercial, multifamily, data centers, and the industrial parts of the market.

We have a majority of Green Lease Leaders in the gold certification signifying that they put leases into practice, and a large number of applicants are integrating green leases into 80 to 100 percent of their portfolio. We also have our first class of platinum tier award winners with nine companies leading the way on environmental and social priorities. In 2022, the program expanded by more than 20 percent, although Green Lease Leaders – not although, sorry, all together, Green Lease Leaders/Partners manage over 500 billion square feet in the commercial and government space.

So can we just have all those Green Lease Leaders, those of you in the audience, can we have you all stand, please? That would be terrific. Come on. If you're in the audience, let's see ya. Come on. Let's see ya. *[Audience applause]* Awesome. Yeah, stay standing, Sarah. Okay. Thank you. So many partners successes to highlight. So thank you all for being part of the family and celebrating the success of many of your efforts and the efforts of your colleagues, peers, and sometimes competitors, but that's what this is about.

So before we move on to our lab panel, there's just one last group of folks I want to recognize. I don't have slides for them, but that is that the Better Buildings team at the Department of Energy. And we work with some great contractors. And together this family pulled off this event, hopefully flawlessly – well, with the exception of Dr. Richmond. But okay. *[Audience laughter]* That's okay. Right? That's okay.

I just want all those folks who are part of the Better Buildings, Better Plants, Better Climate Challenge team to stand up just for a second. If you guys will help me. Sometimes thank yous aren't big enough, but if you will all help me, a round of applause and a big thank you from all of us. *[Audience applause]* truly a team effort I am up here at the podium but it's because of all the hard work

those people do. So thank you to team Better Buildings, Better Plants, Better Climate Challenge. I really do appreciate everything you do.

Okay. Okay. So now it's my privilege to introduce Carolyn Snyder back up to the podium. While she makes a couple remarks, we're gonna move some chairs on the stage. So if you wonder why all of a sudden people moving, it's not a snafu. People are moving to bring chairs on the stage. And she's gonna lead the lab panel. Remember, you've got index cards. This is your opportunity. Stump the lab expert. It's over there at the table. I want you to stump them. I want you to ask them hard questions.

I've asked them to be provocative. I've asked them to share with you as end users and people driving change in your organization, the kinds of things that you should be looking for and paying attention to in the next couple years. So enjoy the panel. And with that, Carolyn, thanks so much for being here.

Carolyn Snyder:

Good morning, everyone. I'm really excited to be here with you today. As Maria said, I'm the Deputy Assistant Secretary for Energy Efficiency at DOE. And I'm so excited to be able to join the different meetings over the last two days, and the exciting ones planned for today. Because as you all know well, our Better Buildings, Better Plants Summit, it's an incredible opportunity to engage with experts across a range of specialties and sectors representing all aspects of our economy and from across our country working tirelessly together to achieve our shared climate goals.

And that's why I'm excited about today's panel. As Dr. Richmond just mentioned, your feedback is essential to shaping the research, development, demonstration, and deployment investments across the DOE and our national labs. And as our inspiring speakers, who kicked us off yesterday in the panel, pointed out, the work you leave contributes not only to economic and energy goals, but also to critical equity, public health, environmental, and national security challenges. And as much as a scientist in me loves to geek out on the latest innovation or technological advancement, it's a real event for addressing those challenges if our work is not grounded in what you were doing in your own organization.

Our job is to develop solutions that address the barriers you face, and solutions that you can implement now and in the coming years. And together as you've heard from our several speakers, those partnerships translate into real numbers on the scoreboard. And

together, you partners in this room have contributed over 3,000 case studies and implementation models, and toolkits that highlight your innovations and efforts to make businesses and organizations more competitive in today's energy economy.

When market leaders like you lean into these challenges, when we work together to find new solutions, and share those with others, that's how we pave the way for all of us to succeed with the daunting challenges in front of us. And so I'm extremely excited as I said to be here with all of you and celebrate the leadership you each do every day in your own organizations driving change. And as Maria pointed out, for years our mantra has been energy efficiency. And we know that energy efficiency is decarbonization.

But we also know that fully decarbonizing our nation's buildings and industrial facilities is also going to require significant investments to power them with advanced energy technologies with lower emissions. And that's why we launched our Better Climate Challenge, where we're working with partners to develop pathways to get their buildings, homes, and manufacturing plants to reduce portfolio-wide greenhouse gas emissions by at least 50 percent within ten years.

As Maria pointed out with the slide this morning, we're so excited that more than 100 organizations have committed to join us in this effort so far. Look around the room. You'll see those members here today with the banner on their nametag. And as Maria said, if you haven't already joined us, remember those members of our team that stood up? Talk to them today. Talk to your colleagues who you see have already joined. We want to find a way to work together. If the goal seems daunting, that's the whole point. It's daunting. But we're going to work together to find pathways that can work for you.

And then in the full spirit of this initiative, we're going to share what we learned with the rest of the market helping others, empowering others to chart their own course. The Better Buildings Initiative creates this incredible mechanism for us to connect across the marketplace for those working day-to-day on implementing solutions and pathways to reducing their emissions with our nation's top scientists, researchers, and engineers. And as I said, and keep this in mind as we welcome our panel, your feedback directly informs DOE's investment portfolio.

We at DOE and the national labs use your feedback regularly. It's one of greatest values we have from this partnership in addition to

the remarkable accomplishment celebrated today. So I really can't stress how valuable it is. So look at your table. Find the notecard. Start to put down thoughts, feedback, and especially probing questions for our panel. And as those of you who have been here before, remember our national labs join us to share what they're most excited about, innovations that they have the possibility of becoming gamechangers for you and your organizations. Today, we have three senior national members joining our panel. I'd like you to come join me on stage now. They really are excited for your questions. They'll each start with brief remarks, and our goal is to reserve most the time for that Q&A.

So please again, look for your index cards and start to get those questions ready to hand off to one of our team members. And with that, we will get ready for the panel. Okay. So first today, we have Dr Craig Blue, who is the advanced manufacturing program manager for the Energy Sciences and Technology Directorate at Oak Ridge National Lab. Craig, over to you.

Dr. Craig Blue: Okay. So I'm going to speak from here?

Carolyn Snyder: Yep.

Dr. Craig Blue: Okay. Well, thanks for having me. Thanks, Carolyn, for the introduction. And I had the fortune of being here a few years ago before COVID, and it was a really exciting environment. Next slide please. I want to set the stage. I'm known as kind of a manufacturing guy. I have been doing manufacturing for almost 30 years. But there's a critical need really to revitalize manufacturing, and I think we're in a state of transition.

But today if you look at manufacturing, nine percent unemployment, 12 percent of GDP, 20 percent of national capital stock moving across 55 percent of patents, 60 percent exports, and then what we do, R&D, 70 percent comes from manufacturing. But the future of production is really digital. And I'm kind of setting the stage here because I think digital is gonna play a critical role also in this transition and decarbonization of industry. As the global demand rises and it's fragmented, we just got done with COVID, and we see the supply chains. Manufacturers need to be agile.

Technologies such as analytics, Internet of Things, advanced robotics, and 3D printing can play a critical role. There's over 500 billion dollars of opportunity for companies that can go from one product to another. Next slide please. So America's critical need to

improve the digital adoption for boosting productivity and transforming how we make things. We've all heard about the digital thread. Right? It's been around decade plus.

But really when you take a look at our SME, small and medium-sized companies, companies under 500, there's 99 percent of our manufacturers are SMEs. And really they haven't afforded the technology needed to step forward and really compete on international market. You know, the gains have been primarily drive by a lot of our large manufactures. So innovation models really need to enable the adoption of the digital thread. Next slide.

So the McKinsey Study that I'm pulling a lot out of was 2017 Made in America, and kind of their projections. So manufacturing needs. Advanced analytics to find solutions and improve margins. Computer vision to spot defects. Real-time closed loop controls. You know, exoskeleton. Smart glasses. Robotics for improved performance. Improved tool maintenance and repair. Almost everything you touch comes off a tool that was made from tooling.

So where can we really do this? And additive manufacturing lends itself to that. Optimized process. Reduce scrap. So really this adoption of digital thread I think will enable and drive electrification and decarbonization of manufacturing. Next slide. So if you look at manufacturing, about a third of energies used there, if you look at that subset, almost a half of it is in process heating. If you look at the process heating, 90 percent that is fossil energy-based.

And so then we start looking at transit technologies, actually can I use induction and things of this nature? Well, then it drives this digital thread, the need for automation, a lot of what I'm talking about. Next slide. So really, and I want to thank Sachin Nibalkar. I'm sure he's here. He's the one that created the slide. I think there's also a variety of pathways to get there in terms of decarbonizing manufacturing. Low thermal budget transformative technologies, things like microwave, RF heating, ultrasonics, where I don't have that phase change, and this huge energy consumption.

Alternative thermal processing as I mentioned. Induction. Infrared. You know, a lot of these advanced technologies, which again drives that need for this third column, which is transformative, supplemental technologies. This is what I'm talking about here. Smart manufacturing. Closed loop controls. And the third which I think has been addressed with this audience pretty heavy is waste

heat management technologies. High temperature heat pumps. Thermal energy storage and the like. Next slide.

So I wanted to throw in a couple of examples where we've actually applied the digital thread. This one here actually working close with our buildings people. And what we did is the precast concrete industry came, and they said we traditionally make molds for precast concrete. We make them out of wood, and then we put a resin. And we're really losing the placard and the workforce. Is there a way to but basically 3D print these?

We stood in, said, yeah, let's take a look at this, and let's work with the supply chain in the industry. So we directly printed the molds. And in this case, we're doing it for the Domino Sugar building in lower Manhattan. We went ahead and we directly printed machine all-digital, and we applied it. And what we found is traditional molds last about, you know, three-four pours before had to be replaced. In this case, about 200 pours, and there is a 40 percent reduction in actual cost. Did all 6,000 buildings off of the molds. AES in Akron, Ohio did the balance of the molds. Next slide.

This one, again, I think is a closer to home. Actually again applying the digital thread and looking at multi-functionality. Can we print walls where we have embedded sensors, heat sinks, and do heat exchange, things of that nature? Actually, this is a follow-on from the previous talk that I was here where we were using sky bam, a basic technology that we developed in house. You know sky cam on football fields, well, we developed a printer that's all cable controlled. And this was printed in that fashion. So taking that technology forward.

And then I think my last slide, I wanted to throw in as we just came off of COVID, this is another area. I actually worked across the DOE lab system, and again applying the digital thread actually directly printing and machining molds for face masks, test tubes. We even converted our carbon fiber line to make N95 media, the filter material. And then we worked our transportation, I point to Johny at transportation. I know he's at NREL, but he used to be our transportation guy.

And we converted a Cummins lines to their filter aligned for diesels over to N95. That material was subsequently sent to DemeTECH in Florida, where they're making three million masks a day, and they employed 1,500 people. But this is to kind of give you a sense of how rapid things can move forward. This was all done in about a three to four month timeframe. So I look forward

to the remainder of this and taking on questions, and thanks for the opportunity. *[Audience applause]*

Carolyn Snyder: Thanks, Craig. So next we have Dr. Johney Green Jr., who serves as the laboratory director for Mechanical and Thermal Engineering sciences at the National Renewable Energy Laboratory. Johney?

Dr. Johney Green Jr.: Thank you, Carolyn, and thanks everyone for having us here. And I guess I have had the fortune of doing this virtually and in person, so it's great to be here. This is my first in person conference in a couple of years so it's really exciting to be, yeah, with a live audience. So yeah, to just to build on what Craig talked about in terms of, you know, digital innovations and controls, I'll give a couple of examples of how, you know, controls can be used to help, you know, improve building energy efficiency as we get toward grid-connected building. So next slide please.

So course you gotta have a graph. Right? You know, you're an engineer or you're a scientist, I mean you gotta have a graph in a talk. So this is just to set the stage of, you know, as we look at the future of our buildings, so you know, you've got, let's say you've got a commercial, you know, retail building. Let's say it's you've got customers coming in and out. Let's say you've got solar panels on top. And now we're moving to a future where we're going to have more electric vehicle charging as well. And so as all these things come together, the use of buildings and our building electric loads are changing.

So if we look at the figure here, and we look at the solid colors, and the gray, orange, and blue, they represent a lot of the building loads that you would have in a big box retail building. And as you can see, you know, as the time changes, which is on the x axis, when the sun comes up you see that curve dip down. And so with your traditional loads, you know, your electric use is being offset by your solar. And then in the evening, it ramps back up again.

And then with that curve on the top, if you add electric vehicle charging on top of that, okay, now you're, you know, getting those loads increasing again during the day, and you've got a really lot of stress on your system, which may have up in size for certain loads, but also cost savings, right, as you have all these different loads coming together. So we really need to have some optimized solutions to do that. So there's really a couple of strategies that I'll talk about, one using thermal storage with some controls, and another using battery storage with controls.

So on the next slide, we have, so if you think about an airport, they're a huge campus. Right? And a lot of airports looking to decarbonize their campuses. And so one of the airports that we've work very closely with is Dallas Fort Worth Airport. They've been a leader in sustainability and decarbonization. And so one of the things that they're doing is they're looking at electrifying their vehicle fleet at the airport. Electrifying the tugs and other vehicles that provide services to the airplanes. They've got, you know, retail inside the airport. They've got, you know, heating and cooling loads they're managing. So it's basically an ecosystem. It's a campus, very large campus there.

And so one of the things that we're doing at the lab is using our Advanced Research on Integrated Energy Systems platform to work with them to help them understand their building loads and looking at how they can use thermal storage techniques to reduce some of those loads of. So I don't know how familiar the audience is with digital twins. So a digital twin is where you have, okay, you have a real, you know, campus, and then you make a model that represents that.

So we worked with the Dallas, Fort Worth team using some commercial software to develop a digital twin of the airport. And then they implemented a control strategy to help them look at their centralized plant where they have a lot cooling. They've got a lot of, you know, liquid cooling there. And so they, you know, in the traditional way that they operate the airport, all the chillers are all on or all the chillers are off. So you recycle them on or off, and they have a certain load profile.

So using some smart controls and knowing when and where they needed to provide energy, they change the strategy with controls. So maybe they're all on sometimes. They're maybe half on. And they were able to, you know, reduce their building loads by about 20 percent using some of these smart control techniques and using thermal storage and dispatching it to their chillers in a more intelligent way. So that's one example behind me to thermal storage that uses really smart controls.

The next example that I have, and there's a – if it works, it's dangerous. There's an animation button at the bottom left, which it's always dangerous to have that. Wow. It works. Okay. So this is looking at our rooftop control units, which once again provide space conditioning. So this is once again, if you look at the – think about a big box retailer. And this example is looking at how do you use controls for rooftop units and battery storage, traditional

battery storage, how do you use that to offset electric vehicle charging loads?

So in the example of the left, the peak demand with, you know, base building and electric vehicles would be almost 300 kilowatts of use as a peak. But using the control for RTU coordination and battery storage, you can reduce that to a little over 100. So you can make a significant change using these types of controls. So we're working with Emerson, and some small cloud-based controls company for this type of strategy. So these are some things that I'm excited about that are emerging, and you know, hopefully will be coming your way soon.

And so Roderick Jackson at our laboratory is our point-of-contact here, and is one person that you can reach out to for more information. So I think my last slide is just thanking everyone. So yeah, thank you for your time and attention. *[Audience applause]*

Carolyn Snyder: Thank you, Johny. And last but not least, we have Bing Liu, who is the building sector manager at the Pacific Northwest National Laboratory. Bing?

Bing Liu: Thank you, Carolyn. And it's quite exciting to be part of this panel, and also with all the audience with you, the leading organizations to learn from each other on the decarbonization of our buildings, and leading the transition to the net zero. The national decarbonization strategies, we usually try to focus on try to make our power grid clean and affordable. Meanwhile, we try to electrify our buildings, and particularly on the fossil generated loads in the buildings. Next slide.

I wanted to introduce there are two technologies. I have really personal passion about that for you to watch out, and also I hope it can be implemented to your portfolios in the very near futures. One is about heat pump, and heat pump water heater technology. The other one is we actually started moving to have load flexibility as the virtual batteries in our buildings. And thank you, Johny, who set up the stage on my second top point. Next one.

Let me talk a little bit about heat pump and the heat pump technologies. If you're coming to the conference yesterday, I'm sure you enjoyed the panels and the discussions on these, you know, find your match of the heat pumps. But what I'm talking about is usually what we need to do to move our next generation of heat pumps to the broader and the faster market adoptions, and the today and the tomorrows. So we have been working very closely

with the market leaders and the decision makers to fully understand what are the main barriers in terms of the market adoptions of this available technologies.

So we identified a few barriers, and we can help move the market. First, for example, we are doing the field validation of 120 volts heat pump water heaters, which could be a plot and a play of any of their homes. So one of the main barriers we identified is with the 240 watts, you know, heat pump water heaters in the homes, a lot of times, we don't have that audit available or it take more cost to upgrade, like to electric powergrid. So with these technologies available, it will significantly reduce their use storage and cost, and make it much easier for installation.

And also there's a new product coming to the market, which is we call the combination unit of heat pumps that can provide both space heating and water heaters to our homes and some commercial buildings. But before we get a product out really to the market, we're conducting the third party validation so we can make sure that the functionalities, the utilities, and also the performance, it delivers what it's supposed to deliver.

So with the promise of this new company systems, we believe can achieve energy efficiency, reduce the cost, and for multiple uses in terms of single family, multi-family, again, and smarter commercial buildings. Also we tried to developed decision tools to help the contractor really find the best match of their heat pumps and specific, you know, their applications as well. So make that very easy for them, not involve a Ph.D. to make that quick decision tools, you know, to find the best product for their particular application.

Last, although not the least, we are also really into the areas, we can turn the heat pump into intelligent devices. So the heat pumps now have a devices that we're testing to negotiate the ways the power grid be part of their attribution to their grid services. Next slides. While working on residential homes, what about the commercial buildings? Well, we tried to electrify the buildings. It is very important we also turn our buildings through the balanced controls and the load flexibles to make that really as attribution to the grid services, and reduce the needs on the infrastructure investment as we try electrification.

So we used the load flexible technologies test in our own campus for 16 buildings, and it improved. We're now able to have load reductions. We also be able to offer 200 kilowatts demand flexible

capacities. After we proved the concept, we worked with the utilities and the key partners testing at much larger scales in the real world. One of the highlight is we're doing over 100 buildings testings in Salt Lake City, and another 100+ in Spokane, Washington, our own backyard of the lab. So the testing is usually a mix of the commercial, residential building, also with their southern unit of the multi-families are all electric. And the testing is usually helping looking into while we're moving into the dispute, any resources without electric buildings, with EV charges, batterie, the PVs, you know, what is the optimized way to really make our loads be part of the virtual batteries for power grid.

So how about scale that up to a size of Texas or across the country? We've recently finished one of these kind of largest study, really yields Texas's power grid to say if we apply this, you know, controllable building loads to that size, I'm happy to report that we see the potential as a peak demand between nine to 15 percent, an annual energy savings for five billion dollars just for the size of size of Texas, not to mention if we can scale up across the whole country.

So next slide, which is my last slides. So it's very exciting to come into this journey together to decarbonize our building and to move our filtered to zero carbon. It's not an easy journey, but I think is a very exciting opportunity to provide the savings to our consumers and also bring more resiliency to our built environment and our power grid. With that, I'm really looking forward to work with you and give us the feedback and that we can really have this journey together. Thank you. *[Audience applause]*

Carolyn Snyder:

Thank you, Bing. So we got a lot of great questions. Keep them coming. We're going to try to get through as many as we can before Maria gives us the hook because we've got important sessions following after us. So I will start with a general one because you've piqued the interest of the room. And so for those who don't have experience in this, what's the best way for a manufacturer to partner with the labs if they're excited about implementing some of the advanced technologies that you spoke about today?

Dr. Craig Blue:

So I'll kick it off. So you know across the DOE system, we have user facilities. Specifically at Oak Ridge National Lab, we have four user facilities in the applied energy space. I'll talk a little bit about the manufacturing demonstration facility. That probably surprises some people that I would. *[Laughter]* But the manufacturing demonstration facility is really a facility that state

of the art in terms of additive manufacturing, composites, metrology, machining, all the things you would need to actually truly assess the viability of a specific technology in an industrial environment. So it's pre, basically, commercial scale.

We have an open call for proposals. You can come in, visit, kind of ground what you wanna look at. Talk to experts. Write a short proposal. It's reviewed by DOE, and we're given the thumbs up/thumbs down, and usually we'll move forward with a cooperate search and development agreement. But there's a lot of different mechanisms. That's one of the mechanisms that can be exercised. The MDF does about 50 percent of the labs, popular research and development agreements on the order of 40 to 50 a year. We also can do user agreements.

In the case of the user agreement, the companies are open to publishing the results, and we work side-by-side. There's no exchange of funds. The company funds their side. DOE funds our side. So that's two mechanisms that can be exercised.

Dr. Johnney Green Jr.: Sure. Just to add onto that, you know, as Craig mentioned, the labs have a, you know, a lot of great capabilities that are accessible to industry and partners. There's also a lot of technical assistance programs as well, which is, you know, definitely an area of emphasis for the department right now trying to make sure that communities and key stakeholders have access to the lab system and have the ability to address any questions that they have.

Especially as we move towards the clean energy transition, we want to make sure that the technologies we have developed are available and accessible to wide range of communities. So Communities Leap is a program that is an example that where just 20 awards were made working with different communities. So there's a lot of vehicles that are out there in addition to what Craig talked about with user programs and industrial collaborations. Also a lot of technical assistance work as well.

Bing Liu: I'll add onto that is while we are lab researchers, but we are also people. We're real here. *[Laughter]* So don't get afraid of the protest. And the one thing we had been really focusing on is the last miles because there's a lot of great emerging technologies invented by the national labs. But a lot of times, you just really need lots of push to really get into the market, something we call that, you know, market transformations. At the PNLs, we really, you know, focus application engineering, which is we work closely with the market to fully understand where are the pain points, what

we can do to remove a lot of risks. And it's through the demonstrations, through the field validation, third party, you know, documentation. And most importantly, lessons learned. Right?

So then we can really have proving technologies transferred to the market so we have, there are real actual homes. We do the technology testing on their campus, and we use our own buildings as a test bed. And actually our facility people aren't too excited about that, but they put out with us. Then we really move in the technologies with the leading organization like you doing a lot of demonstration works before we really scale up.

Another thing we're really working hard to address is the cost, to reduce the cost down, not just there are hard costs, and also a lot of our soft costs. You know, that really helped. We believe it helped moving to market and transmission. So work with us. Talk to us. And we're willing to talk to you as well.

Carolyn Snyder:

Wonderful. Subtitle for the panel: "We are humans as well." So thank you for that. *[Laughter]* And I would say if you ever have a question, don't ever, don't hesitate to reach out to the Better Buildings team, Better Climate, Better Plants. We're here to help make those connections and if you don't already have them established with the lab. So thank you for that.

Our next question is actually follow-on from, Bing, the comments that you were just making about other ideas around accelerating the commercialization and feeling of the technologies that are coming out of our national labs, especially given the urgency of the challenges in front of us. So I'm curious any other brief thoughts that any of our panelists would like to share on that?

Bing Liu:

Maybe I will start. We are on testing a new license agreement. It's called in the trial commercialization. Like, you know, the load flexible technologies I mentioned, you know, we're really ready for any of you to try into that new control technologies into your portfolios. It's really reduced the waste with energies, and also help on your peak load demand as well. So this new trial commercializing license is going to significantly reduce the paperwork and have the technology at your hands. So that's one new areas, we've been working with DOE to try to make their commercialization of the technologies to a decision maker like your hand quicker and with less cost to do it.

Dr. Craig Blue:

So just kind of adding on to what I talked about earlier, specifically in our buildings area, we have a tech collaborations program,

which was modeled after the MDF, again where companies can come in and actually sit down with experts, work side-by-side on new technologies. And in many respects, kind of try before you buy. But I think they hit it right on the head. Sit down and talk to the individuals within the lab. You know, converse back and forth. Really the strength is our industry partners. Our industry partners know where the pinch points.

Another point that she made that I really agree with, a lot of times we work with industry, they got 90 percent the solution. And it may be that we're just adding one part that pushes it over into, you know, true commercialization. So these are key elements. Understanding on a daily basis what industry is up against, and then communicating that is so important.

Dr. Johnney Green Jr.: And just one other example is I know when in the Energy Efficiency Renewable Energy Program, they've had these corporate research and development agreements, or create a call. So for example in the hydrogen fuel cell program, they've had, you know, create a calls on certain technology areas that are relevant with – I mentioned the ARIES platform that we have at NREL that connects to the other labs.

I think the departments think about how to make them more accessible to industry and having almost a quick turnaround mechanism where there is almost a user program model. We have the funding set aside to our rapidly work with industry. So those are some of the things that we're considering and thinking about to try to be more rapid and responsive.

Carolyn Snyder: Great. Thank you. So we've got several questions related to renewable energy. So I will touch on the broad topics, then each of you can dive into one piece of it. One around shedding light on the progress of other renewables that we're not hearing as much about, like tidal wave, geothermal, etcetera. Another about current and future costs cost curves for major renewable energy and decarbonization technology. One around onsite renewable energy generation opportunities besides photovoltaics. And lastly, what are these national labs doing to work with advancing the grid to accommodate more renewable energy? So a lot of big questions. But just to keep us going, why don't each of you jump in on one part of it?

Dr. Johnney Green Jr.: Okay. I guess since I'm from the National Renewable Energy Lab, I'll take the first one on that. I've worked in a lot of these areas. So great question. So I think the first question was, you know, wind

and solar, or water, you know, talked about most prominently when you talk about renewable energy. But there's also water power technology. So there's conventional hydro and pump storage that can be used for longer duration storage for the grid which is really important.

And then I don't know if folks are familiar with the blue economy. But if you think about, you know, remote areas, island areas, you know, areas that don't have access to energy that are out in the ocean, harvesting wave energy and tidal energy is another area of active research within the department. So that's some of the work going on in that space. And then geothermal energy is another a great resource. And not only for energy generation, but also for thermal energy storage and how do you cope with that into combined systems.

And so there's a lot of work going on in the department looking at that. And there's geothermal heat pumps, for example, are another example of that. Wind and solar definitely get a lot from a generation standpoint. But I think water and geothermal, and not only in terms of power generation, but there's a great value of storage and maybe even providing thermal energy to heat and cool spaces. So those are a couple things going on in those spaces.

Bing Liu:

I want to add one thing is don't forget, we actually have very powerful policy tools already in place to really helping us to leading to these renewable integration filters, which is code and standards. And I know you can only appreciate, I imagine, that. *[Laughter]* So as an example, while we see price starting to really continue to drop down for the onsite renewables, and we're also starting to see the emerging increase of the combination off outside renewables with their building batteries as a package as well.

So we're getting to the point is what is the optimized of their designs and constructions between tracking down the energy efficiency and renewables. So we had been actually using their building energy codes to starting to really have more and more mandate requirement of the renewables. We recently also supported DOE to submit their codes requirement for the EV readiness. So this is really a pretty big deal because if that kind of the infrastructure get into the codes, it's giving a really strong signal to the market in terms of, you know, this is coming.

This is going to be the requirement, you know, for the manufacturers and for, you know, a lot of these makers is get ready for that. So we tried building up that market, you know, demand

from the codes and standards perspective to helping us moving to that direction.

Dr. Craig Blue:

And so I would add at Oakridge, we're primarily energy efficiency, but we do enabling things as we look at, say, the renewables. If you say look at, you know, offshore wind. We have a capability of looking at low cost carbon fiber. As your blades get longer, your spark caps have to have basically a high modulus to keep from actually hitting the tower. We're working things like that. Direct printing of molds, tools, things of that nature. The same holds true in the water area and some of the other geothermal. So we've looked at a lot of advanced materials in manufacturing as it relates to those renewables.

Carolyn Snyder:

Thank you. So going back actually to some of the remarks you kicked us off with Craig, there are several questions inspired by the numbers you quoted for SME manufacturers. And one of the questions, I think captures it well. How do SME manufacturers gain access these technologies? How do we help the little guys that don't have the resources to compete with the large big guys who are leaving us behind? What more could we be doing at DOE and the national labs?

Dr. Craig Blue:

Okay. So this is something I'm always very excited about, which is early in my career, I did my own start-up, and it was a hardware actually making things. And it was inherently very difficult. So I went through that. And so while it may seem daunting, actually the national labs are very open to engaging with industry. We talked earlier about existing user facilities and so forth. So you know, get on the phone. Call. Come visit. You'll get the tours of the capabilities. And really interact with the staff.

What we find a lot of times, industry will come and they think maybe that they want additive manufacturing. And they leave with something completely different. And we're connected to the supply chain. So even a relatively small company, and when I say small, I'm talking about three people. Probably the most wonderful example, it'll only take me a minute, EMERGY came to us, a small company actually out of Colorado. A woman-owned company. And she had an idea for low head hydro. But just a handful of people, and she thought maybe we'd print the blades.

And when we sat down, we did a tech collaboration with them. Did a small creda. And we decided, no, what we want to do is we want to be able to print the molds. And then we connected her company to the supply chain. And they did aluminum castings. Within the

one piece of work, she was able to put together ten low head hydro systems and test them in the field. Twelve months later, she signed a deal with GE. And she's just, you know, a company of three to five people. I think that's a perfect example.

But when Bing said, "Engage, engage," because who knows? I always say everyone comes through the door. Everyone is smart. We got to figure out the next great idea might be coming through the door soon. So I think that we have existing programs that are available. And like I said, you know, just come and visit the various labs.

Carolyn Snyder:

Great. Thank you. So we've got a couple technology-specific questions. I'll read three, and you each can just grab one that you're most excited or speak to. The first is around what are the labs doing to address cyber security risks? And each of you have touched on different elements of cloud and IOT solutions. The second is commenting on data. Much of the talks over the last two days have talked about the importance of data to achieve energy efficiency goals.

What do you think of using thermal or heat emissions data from space to monitor and track progress on building structures and to get insights about heat loss activity/ insulation. And alas, a third one to tease you with, your thoughts on the future prospects for measuring and valuing embedded carbon in our buildings and facilities, as well as reducing effective emissions from demolition and construction waste?

Dr. Johny Green Jr.: So yeah, maybe I can jump in on the first one. Cyber, I think that was the question. So there's a lot of cyber expertise in the lab system. So you know, I won't name the lab. But a lot of labs do that. But at NREL, one of the things that we're looking at, you know, we're really focused on our mission is, you know, energy efficiency, renewable energy, you know, working very closely with industry. And so you know, the current grid and the current energy system works in a certain more centralized way.

But as we go to the future energy system that we're looking at and trying to enable is more decentralized, and there's a lot more communication areas, and you know, a lot more areas of potential vulnerability. And so we're looking at how do we architect the future energy system to prevent and mitigate these kind of attacks. So one example that exists, and this was announced by Kelly Speakes-Backman and also by David Turk within the last year. We're working with the department on the Clean Energy cyber

accelerator, where we're bringing in different utilities and partners that are leveraging the ARIES research platform that I talked about to look at different cyber threats and vulnerabilities.

And we're actually working with large and small companies to look at, hey, how can you then, you know, are these handful of threats really serious? And what are some vendor solutions that can address them? So that's one example of how we're really looking at how do we try to take cyber into the future industry system that's coming along with all the different technologies that we're having in the grid.

Bing Liu:

Well, I will add in a little bit. Cyber solutions, we actually are already working with broader communities, we have offered is their control platforms with their cyber protections in that is called Overtone. And it has being used by the small companies and large companies. Particularly when we're talking about advanced controls, you have to address the cyber before you go any farther. We have lot of our work in our advanced controls work in the Department of Defense portfolios.

So cyber security and data protection is the first thing they ask in order to – as the building, and first, the level of the controls. So if you are really interested in this free, but cyber protect the platforms on their controls, please talk to me. And I will connect you to the right people. And we have all the technical system support thanks to Department of Energy. And we can provide that kind of support too. And you also can talk to other users who has been using that platform on the cyber-related controls in your portfolios.

Dr. Craig Blue:

So I would add, and I hate to go on the cyber route again, but DOE ERE Advance Manufacturing Office actually has a cyber institute. CyManII, the Cyber Manufacturing Innovation Institute led by the University of Texas at San Antonio. Open to new membership continuously. There's a broad swath throughout the entire supply chain. It's a great point of entry particularly if you're looking at manufacturing. And there's a good group of people there that are pushing forward. We're serving as kind of a testbed for that, for discrete manufacturing as well as continuous manufacturing. So I would engage there.

Carolyn Snyder:

Thank you. I think that was a good dataset of how much cyber is on all of our minds. So I wish we had enough time to get through all the questions, but we're coming to near the end. So I'm going to go dark and then positive with our last two questions. So the

next one. What scares you the most? What keeps you up at night?
What are we not ready for?

Dr. Johnney Green Jr.: Okay. I'll go first. *[Laughter]* To be honest, the thing that probably troubles me the most is as we develop the new energy system, that we don't perpetuate the inequities that currently exists and that we have technologies that are really accessible for all that we can make, and energy available to all people as best we can. So that's something that we're really passionate about. And that's the thing I'm most concerned about is just making sure that we don't make things more inequitable as we develop these new technologies and implement these solutions.

Bing Liu: Okay. My turn for a confess. *[Laughter]* The most scary part to me is we all feel the tremendous stress in terms of we really need to be competing with the time to move the needles, decarbonize our building. And we all know that electrification is one of the promising technologies to leading us. While we try to make our power grid clean, and to where to find this right balance, and try to electrify building, while at the same, try to clean up our power grid. So the most scary part for me is maybe we install the electrification technologies by the way inaudibly to add in the utility build burdens to our consumers.

So that's kind of a nightmares I usually hope we try to avoid from the beginning. And also, and even burdens to underserved communities because we're really learning how to work with all-inclusive to be honest. So to not to – to bring them more benefit to all and in a cost-effective way. If you have a solution, we're learning here. But it's really worrying me a lot.

Dr. Craig Blue: For me, it's easy. It's I'm concerned about our small and medium-sized companies, and making sure that they get access to state-of-the-art technology. There's sometimes an assumption that say like machining and machine tools, what could you possibly do there? We've developed apps where you can walk up to a machine as it's cutting, and actually pull out your cell phone. And it can listen to the machine, and optimize for feeds and speeds, and double your production for the same exact energy footprint.

But how do you get that out there? And we're working with the supply chain to that industry. But SMEs need to be internationally competitive. So that's my biggest concern. It's the heartbeat of America is the small companies.

Carolyn Snyder: Thank you. So to bring us up to enter the rest of our day, now tell us what you think five years from now is going to be our game-changing decarbonization solution that will be all over this summit in 2027 that we haven't been talking about today?

Dr. Johney Green Jr.: Wow. [Laughter] Yeah, I wasn't ready for one. I think it's going to be, you know, as Craig talked about this, you know, digitalization. I think, you know, getting our phones and apps, and those kind of things. And so I think it's going to be just a lot of these controls and these innovations of how do you make, you know, use your phones and technologies to control different loads and things in the building. So I think that the digital age is really what's really gonna change things over the next few years.

Dr. Craig Blue: So I agree entirely with Johney in regards to this. We've been talking about it for years, but data analytics is becoming real. We have the ability to actually design parts, track them spatially and temporarily, and then actually qualify the parts and qualify a lot size of one. With small companies, if I have to machine, I'll go back to machining, eight parts to figure out how to machine it, and I only have an order for ten, I just lost. So that ability to make parts right the first time. And that's just an example. But this adoption of the digital thread and moving forward, and fully understanding my manufacturing.

Bing Liu: Well, five years from now, I will be very, very excited to see we finally have the policy in place leading a really marketed demand to retrofit our existing building stocks, and in west coast way. So we are part of the teams to support our president, you know, announcement of the National Building Performance Coalition. In five years, several leading state and cities will start to implement that mandatory requirement to counting the buildings with performance accountabilities.

And then with there, you know, consequently leaving it with that. I hope that's gonna be a trend to really change the games in our building efficiency industry. And to see building as a business market for it a lot of technologies, we can help to implement it. So it'll be very exciting to see that happening.

Carolyn Snyder: Thank you. So as you well know, we use the word "partner" and "partnership" to describe what we do here. And as you can hear, we really mean that. So our commitment to you in the coming year is that we strengthen that partnership, the conversation about feedback loops, new and different ways to be working together

reaching more parts of our country. So please join me in thanking our three panelists today. *[Audience applause]*

Maria Vargas:

Thank you all. That was absolutely terrific. I'm about to send you all off into the summit. I just have three announcements if I could. So make sure you fill out your feedback forms. Those are on the app. There's paper copies. We really – I read them. I read every single one personally. Much to the staff's dismay and chagrin, I do. I read every one. So write a note: "Hi, Maria." E-mail me because I will because I'll have read it. So please do send the feedback forms because we're very interested in your feedback in making the summit better for all of you.

If you are interested in joining one of the teams that you saw, the waste network, the water network, the climate challenge, please there are DOE folks roaming around. So find one of them and make the deal. It would be awesome. We'd love to have you. And then just one logistical thing. There is a very cool session called "Choose your own solution" that the industrial team is running. And the location of that has moved. It's not going to be in the Lincoln ballroom. It's going to be the Washington ballroom. The app is updated to reflect that, but I just want to say that out loud here too.

So we have two more sessions for you at the summit. One before lunch. Then we're just gonna networking lunch. There's no programming. The idea is to just have you all talk to each other over lunch. So networking lunch in this ballroom, a session after that, and then that's the end of the summit. So that's our last time, this is our last time to sort of say to all of you, thank you again for coming. We appreciate you're being here. Enjoy the rest of the summit, and have a great day. Thank you. *[Audience applause]*

[Music]

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