Sarah Stubbs: All right, let's get started. Hello, everyone and welcome to the 2023-2024 Better Buildings webinar series dedicated to bringing you the latest actionable insights from leading industry experts. This annual series is a chance to explore the topics, technologies, and trends that affect your organization as well as efforts to accelerate decarbonization and energy efficiency adoption. Next slide, please. Today's webinar is called The New Cool: the Transition to Low-GWP and Natural Refrigerants. Before we dive in, there are a few housekeeping points I'd like to cover. Please note that today's webinar will be recorded and archived on the Better Buildings Solutions Center. We'll follow up when today's recording and slides are made available. Next, all attendees are in listen-only mode, meaning your microphones are muted. If you experience any audio or visual issues throughout the webinar, please send a message to the Q&A box located on the bottom of your Zoom panel. All right, and next slide.

To introduce myself, my name is Sarah Stubbs. I'm an ORISE fellow with the Department of Energy's Buildings Technologies Office, and I will be your moderator today. Next slide, please.

So, for today's agenda, in a minute we're going to do some polls. We're going to learn about who's on the line, who's attending, and what you especially want to learn about today. So, hear from our audience. We have three great speaker presentations. Then at the end, we're going to have some time for open Q&A from the audience. Next slide, please.

So today for our polls, we're going to be using an interactive platform for Q&A and polling. Please go to www.slido.com. S-L-I-D-O.com on your mobile device or by opening a new window in your internet browser. Today's event code is pound #DOE or hashtag #DOE. If you would like to ask our panelists questions, please submit them anytime throughout the presentation. We will be answering your questions near the end of the webinar. You can select the thumbs up icon for questions that you like that someone else submitted, which will result in the most popular questions moving to the top of the queue.

All right, so on to our polls. So, we want to learn about you, who's on the line. So, let's start off with a few polls. So please join us over at Slido. Again, that's S-L-I-D-O.com to respond to the following questions. If you're having any issues, please message our tech support team by using the Zoom Q&A function. So, starting off, what sector best describes your organization? We have a lot of contractors or consultants. I see a fair amount of state

government on the line. Local government giving them a run for their money. Seeing lots of industrial folks, non-profits and NGOs, some commercial real estate, higher ed, food service and grocery. Overall, we have what looks like a great group joining us today. So why don't we check out the next poll?

So, what is your experience with low GWP and natural refrigerants so far? So, answering this question is really helpful for our panelists as they give their remarks and they're going to be able to address their remarks to who's on the line. So, we have a lot of folks who are saying, "What's the big deal? Tell me all about this." We have a lot of folks whose organizations are considering low GWP HVAC systems, and then somewhat fewer people whose organizations are considering low GWP refrigeration systems. Then we have a contingent of people whose organizations already use these low GWP refrigerants. So awesome to see. It looks like a great mix of experience that we have here. I think we can go on to the next poll.

So, what low GWP or natural refrigerants are you most interested in? Of course, so this is a write-in. You can write-in what you want, and I believe you can also upvote some of the other answers that are coming in. So, we're seeing a lot of CO_2 folks, propane, R290, and of course refrigerants have both that technical options like R290 or categories like A2Ls, and then they also have the more common names such as propane. People are looking for energy efficient and cost-effective options. A lot of folks saying they're interested in what goes in HVAC systems. I promise our panelists are going to address a lot of this stuff so you can learn what GWP is. You can learn the difference between CO_2, ammonia, that kind of thing, HFOs, propane. Some folks are not sure. I see a lot of answers about "We want to know what the major manufacturers are going to be embracing" which is a great point. Some folks just saying, "I need to know what the options are." Well, we're going to talk about what the options are today. The substitutes maybe that are drop-in to your existing systems. A lot of CO_2, a lot of HVAC. What could be combined with HFC refrigerant replacement? Some ammonia. We are going to talk about ammonia today, and which ones are best. How do we know which ones to use? What are the pros and cons? So, these are some great answers, and I'm so excited to get into talking about this. So, thank you so much. Why don't we go on to the next poll?

So, what if anything do you find concerning or confusing about low GWP and natural refrigerants? So, we want to just open this up. I know there are a lot of questions. A lot of folks are feeling

like they need to learn about the basics here. We are going to talk about the basics. So, what do you want to learn today? What are you worried about? What is not clear for you? We're seeing some stuff about state policy, how they're being updated, upscaling technicians. Flammability is a major problem. I also saw safety and leaks, information on pricing, more regulations. Regulations are a huge question here we're definitely going to talk about today. So, what's available for a commercial HVAC system? What's the impact? What fits with the green movement is a great question. Drop-in replacements – that's a great point as well. More information about toxic and flammable alternatives and the safety for them. Fiscal concerns about A2L regulations and PFAS. Lots of concerns about regulatory requirements. We're absolutely going to talk about that. What are the benefits? I've seen a lot of comments about leaks as well. So, what are the major obstacles? How do you know when they're compatible? How long they last, reliability, performance. There's a lot to think about here and we're going to address a lot of this. Thank you all so much. Why don't we go on to our next question?

All right, so we've covered a lot in the last question. I think if there's anything you haven't gotten to say yet, what else do you – is there anything you haven't gotten to say yet that you hope to learn about today? Remember some of this is going to be addressed by the panelists, and this is also a great opportunity to ask the panelists to talk about something as well. So how do you reduce CO_2 emissions? What are industry trends and best practices? Phase out timing – we'll absolutely be talking about that. How do you compare your alternatives? Future GWP, limits and good practices. What's coming and what's available now? That's a great question. What are the costs? Absolutely. Some safety issues by refrigerant. We're going to talk about that a little bit. Market readiness. A lot of questions I'm seeing about insulation details as well. Maintenance for efficiency – we're going to get into that to a certain extent. Kind of a lot of questions about what is trending and what's coming. Of course, more questions about regulations as well, which is very understandable. All right, this is so helpful. Thank you all so much for participating. We're going to have opportunities to participate by submitting questions through Slido through that link in the chat. I think for now we can go onto our next slide today.

All right, we have a great lineup of presenters today. We have Michael Deru from the National Renewable Energy Laboratory, Morgan Smith from the North American Sustainable Refrigeration Council, and Mark Minter from AgriPure. So, thank you all for

being with us today. I think we're going on to the next slide and intro'ing our first speaker.

So, Michael Deru is the group manager for the Advanced Buildings Equipment Research group at the National Renewable Energy Laboratory. With over 25 years of experience, he has conducted a broad range of research in commercial buildings including building performance simulations, development and validation of energy efficiency technologies, publishing source energy and emissions factors, water and the U.S. life cycle inventory database. He has authored or co-authored over 100 technical reports in peer-reviewed publications and received an R&D100 award in 2005. With that, I will hand it off to Michael to kick us off.

Michael Deru: Great. Thank you, Sarah, and thank you all for joining today. Very excited to be speaking with you and sharing some information about refrigerants. Go to the next slide, please. Actually, go to the next one. So really, I want to start out why do we care about refrigerants and HFC refrigerants in particular? This is an estimate from the World Meteorological Organization that if we have this global phasedown of HFCs that we could avoid almost a half a degree Celsius warming by 2100. That's a very significant impact and this is why people are very concerned about refrigerants because they do have high global warming potentials and their use is pretty ubiquitous. We want to try to manage that. So go to the next slide.

Let's back up a little bit. In 1970, the U.S. passed the Clean Air Act, and provided EPA with regulatory authority for some of the refrigerants we were using. At that time, we were trying to phase out the CFCs because of the ozone depletion. Section 608 provides regulatory requirements for handling of refrigerants in stationary air conditioning. Go to the next slide.

Then 612 EPA provides this Significant New Alternatives Policy or SNAP. They publish the allowable refrigerant that can be used. So, as they phase out refrigerants, SNAP provide the refrigerants that can be used as – in replace of the old ones. We've gone through these phases of phasing – going through different refrigerants because they work great, but then they have side effects. So, the first ones that we used very early on were – had toxicity issues, and were not – performance was not great. In the 1930s, they started introducing some really great refrigerants like R11, R12, R22, but those had high ozone-depleting potentials so we phased those out, and then we introduced HFCs which have a

high global warming potential, and now we're phasing those out. So, we're in this cycle. Hopefully, we can avoid doing that again, but go to the next slide please.

Then the AIM Act, or the American Innovation and Manufacturing Act of 2020 introduced a phasedown schedule for these HFCs or hydrofluorocarbon refrigerants that are widely used today. This is a pretty significant phasedown. It's not a complete phaseout. It is a phasedown, and it is weighted by the GWP. So, we're targeting the highest GWP HFCs first. Then we continue down to we're down to 15 percent of our 2011-2013 average. So, the AIM Act does three things. It introduces this phasedown schedule. It introduces some technology-specific restrictions for this transition, and it allows EPA to implement regulations that control reclamation and minimize releases from equipment. One thing it does not do – it does not impact existing systems directly. So, you do not have to go out and change HFCs in your existing systems. So, if you have a whole fleet of HVAC systems using R410A or others, you can continue to use those systems. The challenge is that in the future, in ten years from now or so, I don't know what the cost of that 410A is for recharging those systems. So, if you need to recharge those systems, that 410A or whatever you're using could be more expensive. That is still to be determined. We don't know what's going to happen there. All right, go to the next slide, please.

So, the sector specific regulations, EPA just released these guidelines at the end of 2023 that residential and light commercial HVAC, there will be a restriction starting January 1st, 2025 that they have to use – there's a GWP limit of 700. So 410A, which is the most commonly refrigerant in those systems, will no longer be allowed, and they'll have to use things like R32, R454B, or some naturals, or some other refrigerant. There's an asterisk there that equipment that is manufactured prior to – so manufactured this year basically in 2024, they will still be allowed to sell those up through 2025. So, January 2026, there will be no 410A or other high GWP equipment. Then you can see these other restrictions. There may be changes. This is brand new, and so there's often revisions to some of these rules but stay tuned and we will see what happens here. Go to the next slide.

So, then the last part of the AIM Act was managing the use and reuse of HFCs. So, this is a brand new proposed rule published in October 2023. That means it's still out for public comment, but basically EPA says you will have to do leak repair on systems with more than 15 pounds of refrigerants. So that's a pretty small system. Then you should have automatic leak detection for any

systems with over 1500 pounds of refrigerants. The next bullet saying you have to use reclaimed refrigerants or new installation and servicing of existing equipment after January 1st, 2028. So, all the – after January 1st, 2028, that could drive up the cost of those R410A and other refrigerants that we're using today. I don't know what'll happen. There will be a lot of reclaimed refrigerants that will be available to use but may not meet the full market demand. We don't know yet. There's some regulations around the cylinders and containers of HFCs. Again, all of these are proposed, and they may change. We'll just have to wait and see when the final rule comes out. Next slide, please.

All right, so on top of the AIM Act and the federal regulations, there's state HFC regulations as many of you know. The U.S. Climate Alliance.org is one place where these states – there's 25 states that are a member of this climate alliance. There's 11 states that have HFC rules. Some of them are different than the federal rules. So, you'll need to go and see if you operate in those states what those rules are. So, some of those have recently changed, so you'll need to go and see what those are. I can't keep track of them all myself. I don't know what they are to tell you. But let's go to the next slide.

One thing that we do need to be concerned about is refrigerant safety. So, some of these new refrigerants or alternative refrigerants that we're considering have either higher toxicity or higher flammability then what we've often used to date. So ASHRAE standard 15 defines these categories of safety. So, there's A1. It means that there's no flame propagation, low toxicity, and then a lot of the ones that we are considering using in this first effort like R32 and R454B are considered A2L refrigerants. That means they have a low flammability. There's certain safety concerns around that. Then the high flammability like propane and isobutane I saw people were looking at, those we know have high flammability because we use them for cooking and other things. But those there's certainly safety precautions around those. Right now, there's very low charge limits on those. Another refrigerant that is commonly used – a natural refrigerant today – CO_2 is A1. It has no toxicity and no flame propagation, but another one is ammonia. It is a B2L because it is highly toxic and does have a potential for flammability, but it's a low flammability. Next slide, please.

All right. So here are some of the refrigerants today for HVAC package units like rooftop units and chillers. Oftentimes today for rooftop units, we see a lot of – there's still a lot of R22 in

circulation today. Nothing is sold. It's all old existing systems. R410A dominates those systems. What they're looking at for refrigerants in the next couple years or year is R32 and R454B are the two most common refrigerants. You can see the 100-year global warming potentials. Those are what we use for regulations. So, both R32 and R454 qualify under the AIM Act. They're both lower than 700 GWP. For chillers, there's better options I think for low GWP refrigerants. The R513A is one. Then the R1233ZD and the 1234ZE, those are both considered HFO refrigerants. The challenge with some HFO refrigerants, not all of them, is that they do contain the PFAS chemicals, some of them, which are the forever chemicals. That is a concern that we want to be careful about. Next slide.

Just wanted to put out some natural refrigerants. You'll hear a lot more about these in the next two presentations, but CO_2, propane and ammonia and isobutane – I didn't put on here – are 600. Those are the most common natural refrigerants we use today. They work really well as refrigerants, but they do have some challenges that we need to learn how to manage. You'll learn more about that in the next two presentations. All right, next slide. Almost finished here.

So, this is just some resources that are available from the EPA if you want to learn more about the regulations, and then California SNAP because they're a leader in this area. NREL just recently published this HFC phasedown fact sheet last year. There's English and Spanish versions available. The link that I share here is for the English version, but you can also search for the Spanish version very easily. Some of the things that I talked about today from these latest regulations from the EPA are not in that fact sheet because they are very new in the last few months. But everything else that I've talked about is in there today. I believe that is my last slide. One more, and then thank you all for coming today and listening. We'll look forward to answering any questions later.

Sarah Stubbs: Thank you so much, Michael. Now, we're going to go onto the next slide, so we can hear from Morgan Smith. Morgan is the Program and Communications Director at the North American Sustainability Refrigeration Council or NASRC. She has a background in sustainability, communications, and project management with a particular interest in aligning business goals with sustainability solutions. Prior to her role at NASRC, she managed forest management programs for landowners at the American Forest Foundation. Morgan, the floor is yours.

Morgan Smith: Thank you so much, Sarah. If you want to go to the next slide. So just a quick step back. A little bit about NASRC and why I'm here talking about this today. We're a 501(c)(3) nonprofit. We work in partnership with the supermarket refrigeration industry to address some of those barriers that Michael was talking about to natural refrigerants. We were founded about eight years ago by stakeholders from the supermarket industry who saw a need for an organization focused specifically on CO_2, propane, and ammonia primarily because those refrigerants can't be patented and as a result, there's not a natural champion to address some of those challenges and make those a strong business choice. We've grown quite a bit since that time. We work now with over 160 organizations across the industry and focus together on building a sustainable technician workforce, increasing funding support for natural refrigerant options, and improving education and technology optimization. I'll talk more about how all of that applies here, but really all this has become much more important and urgent amidst all of the regulatory pressures that Michael just spoke about. So next slide.

I want to acknowledge that this is not the first time the industry has gone through something like this. It started back with CFCs and HCFCs which, as Michael acknowledged, were phased out because of their ozone-depleting characteristics. That was through the Montreal protocol at the international level which took us to the refrigerants that we commonly use today – HFC refrigerants like 404a or 507A. They came into use as alternatives to those ozone-depleting refrigerants. Unfortunately, we then learned that we effectively replaced one environmental catastrophe with another when we learned that these refrigerants have extremely high global warming potentials, which is really bad news for the industry because that means yet another refrigerant transition. HFCs are a drop-in solution to CFCs, and what that means it they don't require a full system replacement. So that's a much more cost-effective way to do the transition. But of course, they are now on their way out through international, federal, and state level regulations. So where do we go from here?

There's a few different directions the industry is taking. So, the next class of refrigerants is what we call HFO blends. These are a blend between HFC refrigerants and then the newest class of refrigerant, HFOs, or Hydrofluro-Olefins. This category is very broad, so not all of these characteristics on this slide are exactly right. Some of these blends are pretty easy to retrofit and continue to use existing equipment and systems. So, refrigerants like 448 and 449, you can do a gas changeout with just a few component

changes. Some of these are less so, and still require quite a bit of equipment replacement. The biggest implication here, and Michael brought this up as well, is that the HFO portion of these refrigerants are at risk of being classified as PFAS. For those who are not following this issue, PFAS is a class of chemicals sometimes called forever chemicals. There's a lot of concerns around their impacts to public health and human health. In Europe, many HFO refrigerants have been classified as PFAS which puts them at risk of future regulation and restrictions. That has not happened yet in the U.S., but we are starting to see a number of proposals at the state level. So, it's just something to be aware of, something we're keeping an eye on.

So that brings me to the next class of refrigerant – pure HFOs. These are much lower GWP alternatives, in many cases less than 10. Again, they have that concern about PFAS, but they are not subject to the new HST regulations that Michael just reviewed. They are not a drop-in solution. Then finally, we have natural refrigerants such as CO_2, propane, and ammonia. They are non-ozone-depleting, ultra-low GWP, exempt from regulations, not as risk of being classified as PFAS. They're market ready, but the challenge again here is that they are not a drop-in solution. So, there's no silver bullet I've heard many times from Tristan Coffman and other folks in the industry. The industry is in a difficult position. It needs some solutions to navigate this transition. Next slide.

So, this is really just to show the massive gulf we have and the GWP difference. The GWP, global warming potential, it's really the potency of a greenhouse gas, how much heat it traps in the atmosphere. So, you've got the high-GWP HFCs at the bottom here, those HFC/HFO blends in the middle – the retrofittable ones, and then natural refrigerants at the top. You can see this is a very big difference and one of the reasons that natural refrigerants are highly regarded as the most climate friendly and future-proof option. Next slide.

I just want to acknowledge while regulations are a major driver here, they're not the only driver. Corporate climate commitments have risen significantly in the last few years, and I think more and more businesses are starting to realize that it's not possible to achieve those climate targets without addressing refrigerants. At the same time, as awareness of the impacts of HFC grows, there's an increase in public pressure on businesses. So, this is just an example of a campaign that Green America ran recently to target Kroger, putting a lot of pressure on them. Next slide.

So, all of this stacks up to a significant increase in the demand for natural refrigerants. This graph is based on a survey that we did last year where we surveyed 13 major food retailer companies that represented over 18,000 U.S. store locations. We looked not only at the number of CO_2 stores that they currently have installed, but also how much we expect that to grow over the next five years. You can see here that the projections over 300 percent growth by 2027. The majority of that growth is actually from remodels, which is significant because again, because these refrigerants are not drop-in, that means there's a pretty costly and challenging full system replacement required. But a number of retailers are seeing the writing on the wall that this is going to get them out of this cycle of transitions. So, we are planning to redo this survey this year, and expand to include other refrigerants and really get a better idea of where the industry is headed. You can expect to see some updated data released by us later this year. Next slide.

So, despite there's a rising demand, the industry is certainly in a transition already, but there's still a number of barriers that need to be addressed before the food retail industry and really the refrigeration industry can make this transition on a widespread basis. There's four areas where NASRC works. This is our theory of change and this first one is well underway, now as demonstrated by that last slide. There's already a rise in demand but there's definitely an ongoing need for knowledge and information sharing across the industry so that we can move forward together, share lessons learned. A rising ride lifts all boats. Then the second as to advanced funding support, there's a real need here to offset the cost of these projects, especially for smaller businesses, and especially for existing facility remodels. The third need here is to optimize technology options. This can be done through education, technical guidance, updates to codes and standards, performance studies. All of these things are needed. Finally, last but definitely not least is workforce development to build up our technician workforce and make sure everybody is trained and ready to install and service these technologies.

In the next slide, I'll talk a little bit about funding. Our vision for funding has always been to pull together as many funding sources as possible to support these projects. So, this is really to help offset that high price tag when you're doing particularly an existing facility replacement or remodel. We worked on a number of funding sources over the years. It's an exciting time in the industry because we're starting to see more of these funding sources come to fruition right now. So, starting with state funding, it really all

started here in California. When they allocated a million dollars to their F-Gas Reduction Incentive Program in 2020. That program has now grown to $65 million dollars which is really exciting. I'll talk more about that in a second. But I would say of equal importance, that program provided a model for other states to follow. We've already seen other states taking steps towards that, expressing an interest in this, and so that's something that we're continuing to push for. Carbon financing, we did a small pilot a few years to try to get this market off the ground, passed it over to our partner, Therm Solutions, who took it, ran with it. They now have I think over 1,000 projects under development. This is a great option for smaller businesses. The revenue for the sale of carbon offset credits gained from these projects. And so, it's a great option for smaller businesses that don't necessarily need to claim those credits but don't necessarily have the capital to invest in these types of projects. Less appealing to some of the larger chains and larger businesses because sometimes claiming those credits is more valuable than the revenue. Then lastly, utility incentives. Of course, this is for energy efficiency but also there's a big push right now to try to incorporate refrigerant and GWP into utility incentive metrics so that businesses could get incentives not only for the energy savings but also for the emissions savings. Next slide.

So, for the FIP Program California, this is a really big opportunity coming up for the industry. We're the third-party administrator for this program. So, we're working on it actively right now. $65 million dollars will be available. The goals of the program are to accelerate the replacement of HFC equipment with refrigerants below 10 GWP to prioritize disadvantaged communities and small businesses and focus on direct refrigerant savings. So not energy savings, which is great because that gives us an opportunity to stack with other incentives for energy savings. In terms of timeline, we're currently developing the funding guidelines in partnership with the California Air Resources Board, so we'll be announcing some opportunities for public input in the near future, and we hope to launch the program in Q2 so stay tuned for more updates there. Next slide.

So even if we have all the funding in the world, the market is ready, businesses are ready, we do have a major challenge in front of us. We really don't have enough technicians to do this work. We are facing a critical shortage of technicians, and at this time when the industry is doing this transition, we need to build that up. Our workforce is retiring out. There's not enough new technicians entering the field. It's really putting a lot of strain and pressure on

our existing technicians which is causing this burnout loop and exacerbating the issue even further. Next slide.

So we see that the way we have to do this, we have to come together as an industry to focus on three areas in tandem: recruitment, bringing more technicians into the industry – that's much broader looking at HVACR programs, but also much broader than that, training – providing training on the basics of refrigeration but also on natural refrigerants and other advanced refrigeration technologies – and retention – making sure we're not losing the technicians we already have. Next slide.

So very quickly I'll just acknowledge we've got a number of natural refrigerant training summits that we're hosting this year. These are free three-day events where we sent 300-ish technicians to one place to get access training from all of the different manufacturers and industry experts all in one place. We've got a few coming up in Pittsburgh in March, Irwindale in April, and Seattle in November. If you're interested or if you know any technicians, please feel free to forward this to them. It's a great opportunity to learn. Next slide.

I think that's it. Thank you so much.

Sarah Stubbs: Wonderful. Thank you so much, Morgan. I think we can go onto the next slide. A quick reminder to our audience for the very end, to send in any questions you have at www.Slido.com. That's S-L-I-D-O.com with the event code #DOE. We look forward to answering your questions at the end of the session. But first, we're going to hear from our final speaker, Mark Minter. Mark is an energy engineer for AgriPure, one of the world's top 20 dairy producers. For the past ten years, Mark has been the engine behind most of AgriPure's award-winning energy efficiency projects across all U.S. manufacturing facilities. Recently, AgriPure has committed to reducing its greenhouse gas emissions by 30 percent by 2031 with the goal of achieving net zero emissions by 2050. Mark worked closely with the emissions reduction target setting team to make sure these numbers were grounded in operational reality. Mark, take it away.

Mark Minter: All right, thank you, Sarah. Next slide.

Yes, Mark Minter here. Energy engineer from AgriPure. I'm here to talk about really our ammonia systems. You can go to the next slide.

As you said, we are a very large area manufacturer. That's why we need lots of ammonia. We use ammonia for the majority of our refrigeration systems. Certainly, in manufacturing is all ammonia. We do have some other refrigerants maybe in office areas that are different, but we make just large quantities of cheese, so 400-500 pounds barrels of cheese and whey proteins. It takes a lot of cooling to do that. So, next slide.

So where do we use our ammonia? We use it in silo cooling. All of our cheese starts out as milk. It comes in. We put it in these silos. They have to maintain the right temperatures. In summertime, it can get quite warm. These are jacketed with insulation, but we certainly do provide cooling to these and it's used a lot more in the summer, but certainly an area that we definitely need cooling. Next slide, please.

We also have a chilled water loop in all of our plants. In areas where we don't want direct contact with ammonia on some of the cheese and other areas of the plant, we have these chilled water loops that go throughout our whole facilities. So, this left picture here is actually an ammonia plate and frame heat exchanger. So, you'd have ammonia on one side, and the chilled water on the other side. These are quite large. Each of our plants have a couple of these to provide the cooling. That really gives the rest of our plant anywhere from 30 to 40-degree water. We usually use water. Some plants if you're below the freezing level, you might have a water/glycol mix, but in our plants, we're generally just water. We're above that freezing temperature, and so what we do is we send that chilled water out then to – one of the first areas it goes is the milk pasteurizer. So, we have to pasteurize all of our milk. On the whey side, we pasteurize that also. What that does is it heats the milk up, kills up any bacteria, things that might be in it. Hopefully there is nothing, but it's just a safety precaution. Then we've got to cool it back down.

One way we do that is with chilled water. This picture right below it, it shows mozzarella brine baths. When we're making our mozzarella cheese, it goes – the hot cheese goes into these brine baths and actually sits there for about 20 to 24 hours and soaks up some of the brine, gets flavoring and things from that. We're always adding warm cheese to this brine. We've got to constantly keep the brine cool. So, what we do is we provide chilled water to that. We also have a lot of compressed air in our plants. So, when you're compressing the air, it gets hot. That hot air also has moisture in it, and if you send that out to your plants, it can mess with some of the valves and things that might be controlling. So,

we have to drop the moisture out of the air. How we do that in a lot of our plants is with chilled water. So, it goes through that chilled water loop there, drops the temperature and drops the moisture out. Another area is for oil cooling. This is air compressor which we have chilled water going to it to provide the oil cooling. There might be other pumps or motors or fans that would need external cooling. One of the ways we can do that is with our chilled water loop also. We use a lot of chilled water in our plants. Next slide.

Then of course, once we make the cheese, we have to keep it cold or cool. We do that in large warehouses. These warehouses are very large, and they each have these evaporator coils in them. So just like small refrigeration system. These are for very large warehouses. Each one has ammonia lines you can see going to them. We provide – drip the ammonia into there. Keeps it cool. We also have some instances where we need to freeze the cheese. Maybe we're shipping it overseas or something or a long ways, or it needs to be chilled for a while. All the cheese would go into these blast freezers, packaged of course, and then we use ammonia to cool them down and get them real cold with ammonia. Those are some of the ways we use ammonia in our plants. Next slide.

Why do we use ammonia? We've actually been using it for – I've been with the company for ten years. They've been using it for 20 years before that. It's something that we've just used a lot of. It really comes down to the efficiency and the cost of it, for us anyway. Efficiency and cost go hand in hand. You get really good heat transfer rates with ammonia. That requires smaller equipment. Really, it's the less surface area where you're doing that heat transfer. All our plants and areas are already pressed for space. If you can keep the equipment smaller, that's a bonus. The smaller equipment also has smaller costs, so the pipes, fittings, things like that, ammonia, just the cost is fairly cheap. I don't actually buy it, but I do know it's fairly cheap. Then ultimately, I'm the energy engineer for the company, so our electric costs stay really low with ammonia. It's one of the cheapest ways we can keep our plants cool and provide the cooling is with this ammonia. Then more recently, it's all the environmental and that's why we're here today. So, it's got the zero global warming potential. It's got zero ozone depletion. That's good. We do a lot of reporting now, and we're starting to do more and more of that, so we have to report our scope 1 and 2 emissions. If we were to do our cooling with one of these other refrigerants, that would definitely add a lot more to our plate. Luckily, with natural refrigerants, we don't really even have to report those numbers. In a way, it's future-proof. I think both presenters have touched on that. We do know we don't really

have to do anything with our system, which is nice. Next slide, please.

There are cons of course. It's poisonous to humans. It does smell if there's a leak. It's lighter than air. We haven't had any leaks. Of course, you have sensors and things that will go off. We maintain a very, clean, safe ammonia rooms. It reacts with copper. So, you've got to be careful with some of the pipes or fittings that you might install. Of course, that goes down to training of your mechanics and things. Then it can be hard to manage. We definitely have a good process safety management program where we have annual inspections. We do audits. We make sure there's the proper signage everywhere. We just try to be as safe as we can. We've been doing it for 30 years with no issues. It can be done. Next slide, please.

These are some of the safety items or safety precautions we've taken. Anyone who might need to go into our ammonia rooms has to go through our ammonia awareness training program. It's some paperwork and safety things we go over before we let anyone in. Of course, there's other equipment in there, so you might have a pump in there. You might need someone to get in and service that pump. They don't have to go through the proper training. We also – some of these rooms can be very large. We have ammonia compressors in there with storage tanks for ammonia and things. They might be in an area of the plant or other people might want to cut through there. We don't really let them. We have alternative routes around all the ammonia rooms. We keep them locked if needed and try to only allow the right people in there. Then, of course, we do have SOP training. That's for maintenance crew. If things break down or what-not, we need our plants running 24/7. We do have maintenance guys who can get in there and work on them, and of course they go through all the proper training to make sure they're safe. Next slide, please.

All right. Now, I'm the energy engineer for AgriPure. I know this is the most efficient way we can do our cooling. So, I thought I'd talk about some of the projects we've done over the last ten years to really keep our costs down. The name of the game in refrigeration is reducing the lift. That's the difference in your discharge and your suction pressures. One way you can keep your discharge pressures down is with cooling tower capacity. Here, we're rejecting the heat to the outside with that cooling tower. We have had times where our plants grow. We don't have the ability to reject enough heat outside. We have to add more of these cooling towers and that really helps keep those pressures down. Keeping

coils clean from scale, that's a big issue. Water quality can be a big issue in our plants. We try to keep the cleanest water going to these that we can. That's all part of a good water management program to really, in any of the plants. Then we want to float our pressures. So, in the summer, temperature and pressure are dependent. So, in summer, it gets hot. We want to float our pressures up when it gets hot, and then back down when it cools down. On the suction side, this is where you're doing the cooling down in your refrigeration. We want to have low or freezing. We do freeze some of our cheese as I said. We don't want to keep the whole plant at that low, low temperature if we're only freezing 20 percent of our cheese that day. We have the higher side for refrigerated sections. The next slide, please.

Some other things we like to do is we add variable frequency drives to any motor, pump, or fan that has a varying load. So, in the past, these fans have pumped motors or compressors would just be on. They'd just run at 100 percent no matter what the load is in your plant. We went in and retrofitted all our fans, and our ammonia compressor, the BFDs, our evaporator fans with BFDs and our condenser fans with BFDs. We are seeing a lot of savings just in electric costs by doing this. Next slide, please.

Then we also, so we're reducing parasitic loads. That can be a big issue in some plants. This can go down to employee training. People leaving doors open, leaking doors, broken strip curtains, or areas where you're overcooling. Those are all very common things we've seen. We just have to fix them or do some training on them. High speed doors are great. These doors open real fast. The forklift can go through them. Then they close them real fast. You only have the door open for maybe 10 – 20 seconds for a couple minutes where you're just losing that cold air going out to the rest of your building the whole time. Evaporator – hot gas defrost. So, with our refrigeration coils, whenever you get warm air into the areas, it could – there has the potential anyway to have frost on these coils. So, you have to defrost them. You defrost them by adding hot air into it or hot gas into this coil, which just raises the temperature in the whole freezer. In the past, this has been done. You might do it once a day just to make sure the coils are clean. We have started testing these sensors that go in, and they only put the hot gas into them to defrost when there's frost. So, it might be once a week now versus once a day. Also heat recovery. Thermocycle and oil cooling is one way. If you're getting a new compressor, it's a pretty cheap add-on you can do. Then look for any pre-cooling. So, some of our plants, they all do heating and cooling at different times. Maybe you can take some of the cooling

off one area and do some pre-cooling. Just something to look for. I think that's all. Next slide.

Thank you.

Sarah Stubbs: Thank you so much, Mark. Thank you again to all of our awesome speakers. We have just a couple of minutes left, and we're going to go and move onto Q&A. So, if you haven't already, please join us over at Slido.com with event code pound #DOE or hashtag #DOE to submit and upvote questions. All right, so first question, I'm just going to dive in. If our panelists want to be able to be on deck to help me answer these. Should we hold off on equipment replacements such as energy efficiency upgrades and electrification with heat pumps until low GWP refrigerants are ready? A lot of people upvoted that. Would any of our panelists like to take a stab at that one?

Michael Deru: Yeah, I'd be happy to try to take a stab at that. That's a great question, and it's always a balance of when do you replace equipment. I would recommend not doing early replacements. Maintaining those systems, and really controlling the leakage is going to be the most important thing. There is going to be a lot of changes over the next few years in the market, but it's hard to predict exactly when very low GWP refrigerant systems will be available. But you just have to keep watching that. Keep an eye out on it. I would say over the next five years we'll see some lower GWP options available for HVAC systems and improving refrigeration systems as well. I hope that helps.

Morgan Smith: I would just add that different sectors of the market are in very different places like Michael said. HVAC is a totally different animal. Commercial refrigeration, I think those technologies are ready to deploy and market ready. It's a matter of figuring out the right solution for your facility and whether you want to do a full system replacement or replace components of it with modular solutions over time. There's really no one size fits all.

Sarah Stubbs: Thank you. I think we have time for about one more question. The next question that's also been upvoted many times – can I upgrade refrigerants in existing systems?

Michael Deru: I can – or go ahead, Morgan, if you want to start.

Morgan Smith: No, no, Michael. I'll go after you.

Michael Deru: Just for HVAC systems, you can upgrade the refrigerant, but you have to be very careful. Make sure you have a compatible refrigerant for your systems, and really confer with the manufacturer before doing anything. I would not recommend it unless you have a really good plan, and the manufacturer fully supports that and provides training and all the guidance on how to do it.

Morgan Smith: I would just say in commercial refrigeration, the retrofittable options where you can continue to use an existing system for the most part, are not – they're more of an interim solution. Many businesses are using them as a way to temporarily reduce GWP while they figure out their plan to go further. But right now, there's no – in commercial refrigeration, no option that's less than 150 GWP, which is where a lot of the regulations are setting a threshold that can be dropped in. So yes and no.

Michael Deru: One more thing to add. Remember, if all of the refrigerant is contained, there's no climate impact. It's only when it's emitted, leaked out of the system, and those leaks can occur if you're evacuating the system and then recharging with a new refrigerant, there's leakage that could occur. So just be very careful about – and balance what is the leakage in your system, and what do you think might leak during a changeout?

Sarah Stubbs: Thank you all so much. Thank you to everyone who submitted questions. I know we only got through a couple of them. I'm going to have to move us on in the interest of time, but we're going to do our best to respond to these questions through our follow-up. I think for now we can go on to the next slide, as I just close things up here. So, thank you everyone once again and to our panelists for their insightful responses. This webinar is a part of our 2023-'24 webinar series. As you can see, we have a great lineup of presentations through March. You can go through the Better Buildings Solutions Center to learn more and register. Next slide.

We hope you can join us on February 13th for our next webinar, which is focused on reducing commercial tenant and scope 3 emissions. You'll be able to join this webinar for the same fantastic experience hearing from Better Buildings leaders and industry experts. Next slide.

A shameless plug for our Better Buildings Better Plants Summit. Registration is now open. The summit is going to be held in Washington, D.C. from April 2nd – 4th. We would love everyone to join. In addition to engaging, interactive sessions, attendees can

look forward to plenty of opportunities to network with their fellow industry peers and experts. So, you can check out what the session tracks will be and book your accommodations on the Better Buildings Solutions Center. Next slide.

One more plug for the Better Climate Challenge Roadshow Cleveland Edition. Check out this video series of DOE energy experts visiting several of our Better Buildings and Better Plants partners to see how organizations are putting decarbonization strategies into action. So, rock on and tune in to the full series on the Better Buildings Solutions Center today. If you can't tell, Better Buildings Solutions Center is where you can find all of our awesome resources. I highly encourage you to check it out. Next slide.

With that, I'd like to thank once again our awesome panelists so much for taking the time to be with us today. Feel free to contact our presenters directly with additional questions, or if we couldn't get to your question during the Q&A. I encourage you to follow the Better Buildings Initiative on LinkedIn and X for all the latest news. You can find our handles by their respective icons on the left half of the slide. You'll receive an email notice when today's recordings, slides, and transcript are available on the Better Buildings Solutions Center. With that, thank you everyone and have a great day.

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Additional Speaker Q&A:

Better Buildings does not endorse or recommend any product or technology provider. The answers in this document are solely the opinions of the speakers based on their professional knowledge and experience.

Additional Questions

Audience member: Why is 20-yr GWP higher than 100-year GWP?

Morgan Smith: HFC refrigerants belong to a class of greenhouse gases (GHGs) called short-lived climate pollutants (SLCPs), which have shorter atmospheric lives than other GHGs. This means that their climate impact happens on a much faster timeline and their 20-year GWP is much higher due to the near-term climate impact. While the 100-year GWP is the standard metric for many GHGs, it does not show the short-term climate impact of SLCPs like HFCs

Audience member: The GWP100 was established in the 1990s when we all thought we had time to address HFCs that have a lifespan in our atmosphere of 20 years. Now we still use GWP100 even when we don't have time and a GWP20 is far more appropriate. Why?

Morgan Smith: Yes, the 100-year GWP has been the standard for most GHGs for many years. While not widespread, we are starting to see some shifting towards the 20-year GWP. For example, New York State is legislatively mandated to use the 20-year GWP for their proposed HFC rulemaking that was released at the end of 2023.

Audience member: I want to share the NASRC training to local community college students. Are there prequalification requirements for taking the training?

Morgan Smith: That is terrific! These trainings are open to refrigeration technicians, food retailers, HVACR students, and HVACR instructors located in North America. Please feel free to share with anyone who may be interested! https://nasrc.org/natural-refrigerant-training-summits

Audience member: How can we use the advent of A2Ls and A3s as the perfect opportunity to engage, train, retrain and retool the workforce so that we're not only helping support new equipment installs, but also address leaks in existing equipment?

Morgan Smith: The biggest challenge the industry faces amidst the transition away from HFCs is that we simply do not have enough technicians to enable all of the projects that are being planned. There is a tremendous need to grow our technician workforce. At the same time, the transition is an outstanding opportunity to expand training

opportunities for technicians. Growing, training, and retaining our workforce will be critical as we enter into this new phase.

Audience member: How likely is Propane to become a refrigerant permitted in buildings in the US? I believe it is in widespread use in Asia but is also classified as A3 - highly flammable. Are there applications where A3s can be used safely?

Morgan Smith: Propane is already safely and widely used in commercial refrigeration applications already in the US today. Worldwide, there are billions of self-contained refrigerated cases, also known as stand-alone or integral units.

Audience member: Do you track a KPI that indicates the electrical efficiency of your refrigeration systems? If so, what is the KPI?

Mark Minter: Yes, where possible we trend amps on compressor, suction pressure, discharge pressure, outside air temp. For KPI's, we look at total amps on the compressors during various discharge pressures and outside air temps. This ensures we are floating our pressures and load trimming correctly.

Audience member: What are the frost-detecting sensors you use?

Mark Minter: HB Products Model - HBDF - Mk2 Defrost Sensor.