Andrew Whitlock: All right, good morning again. Thanks for joining us. Welcome to the 2023-2024 Better Building 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. Today's webinar is called Cool Runnings: The Race to Phasedown Industrial Fluorinated Gas Emissions.

Before we dive in, there are a few housekeeping items that I'd like to go over. So please note that today's webinar will be recorded and archived on the Better Buildings Solution Center. We'll send a follow-up when today's recording is posted and when the slides are available.

Next, I want to let you know that attendees are in listen only mode, meaning your microphones are muted. If you experience any AV issues, please send a message in the Q&A box located at the bottom of your Zoom panel.

My name's Andrew Whitlock, and I'll be your moderator today. I've been supporting the Better Plants program since April of this year, but have spent time working for the Department of Energy in other capacities, previously at ARPA-E and the Energy Information Administration. I also did spend some time doing industrial decarbonization research with the think tank The American Council for an Energy Efficient Economy. Next slide please.

So brief agenda for today. We're going to go over some introductions and welcome polls. Then we'll dive into the speaker presentations followed by some Q&A and concluding slides. Next slide please.

So we're talking about fluorinated gases today, and gases which are a family of synthetic gases that have high global warming potential. And these gases are used across products and industries ranging from AC and refrigeration to electronics manufacturing. And so when I say these have a high global warming potential, you can see in this graphic it ranges from 140 to over 23,000 times the global warming potential of carbon dioxide.

And you'll see that they're grouped into three categories: hydrofluorocarbons, which are primarily used for refrigeration and air conditioning, and things like foam solvents and aerosols. We've got the perfluorocarbons, the PFCs, used in the manufacturing of

electronics like LCD displays. It's also a byproduct of the aluminum industry. And out there on the right we've got sulfur hexafluoride, which is the single most potent greenhouse gas. It's used as an insulating gas for switch gear in electricity transmission and distribution grids.

So because of the high GWP, these F-gases can make up a significant portion of an organization's greenhouse gas emissions. So eliminating these emissions either through improved management or alternative sources can lead to significant GHG reductions, which is important for many companies, with net zero and other GHG reduction goals. Next slide please.

So, their use is growing rapidly. This chart is a little outdated, but it shows what unchecked growth could look like. In 2019, F-gases were estimated to be about 2.4% of total global greenhouse gas emissions in a CO2 equivalent. But if left unchecked it could increase to more than 20% of global GHG emissions by 2050.

And so you'll see in this chart that the major drivers here are commercial refrigeration and air conditioning. And part of this is because these F-gases, these HFCs in particular, were used to replace CFCs which had high ozone depletion potential. Next slide please.

So another driver is the HFC phasedown schedule, which is mandated by the American Innovation in Manufacturing Act. So there's the baseline of consumption and production, which will ratchet down over the next years. We're entering the 2024-2028 year where the allowance needs to reduce down to 60%. So this is a really important time for both industrial and building users looking to reduce their reliance on HFCs. Next slide.

So with that brief introduction, we're going to roll over into Slido to get a feel for who's in our audience and your relationship with F-gases. So, this is an interactive platform for questions and answers and polling. So please go to www.slido.com, using your mobile device or opening a new window. And you can enter the event code pound DOE or hashtag DOE, depending on what generation you're from.

I should note that if you'd like to ask our panelists questions, this is the place to do it. Submit them at any time throughout their presentations. But we will be answering questions at the end of the webinar. You'll be able to select thumbs up icons for questions that you like, which will result in the most popular questions moving to

the top of the queue.

Great. So let's get started with a few of these polls. I hope you've joined us over at Slido. If you haven't, you can scan the QR code or go to slido.com and use the code.

All right, so we're already getting some responses in. Tell us what sector best describes your organization. We want to know who's joined us today. Great. We've got a big group from industry, state government, utility. Fantastic. Looks like 48 people have weighed in, so we'll give it another minute or two to let people respond. Awesome. A bunch of Better Plants partners, I hope. Thanks for joining us.

Okay, let's go ahead and go on to the next poll question. What's your primary use for F-gases or source of F-gas emissions for your organization? We've got HVAC, refrigeration, process cooling, it's like chillers. You use some products, phones, aerosols, solvents, and others. Yeah, no surprise here. Seeing HVAC at the top of the list.

All right, another reminder to folks, if you haven't already please join us at Slido to cast your votes, and to ask questions. All right, let's go ahead on to the next poll question. Does your company service its own comfort cooling equipment and/or process cooling equipment? Let us know. A lot of organizations service both. That's great. A reminder for me to service my own home's comfort cooling and process cooling equipment. Gotta clean those coils.

Okay, fantastic. I think we can go ahead and move on to our, today's presentations. So we've got a great cast. We have Sean Uhl and Andrew Pansulla with Chemours. Kevin Durocher of ABB and David Ocamb with Trane Technologies.

Sean Uhl's the Sustainability Technology Director at Chemours. He has over two decades of experience in the chemical industry with a deep expertise in site operations, process development and continuous improvement activities. In his role, Sean works collaboratively with Chemours's three businesses, titanium technologies, thermal and specialized solutions, and advanced performance materials, to ensure the company continues to lead in sustainability and is well positioned for the future.

His colleague, Andrew Pansulla, is a Technical Service Engineer for Chemours refrigerants. Over the past ten years with Chemours, Andrew has been working on the development of next-generation

refrigerants for the HVAC industry, with a focus on optimizing and troubleshooting these systems for new refrigerants, developing refrigerant management plans, and achieving regulatory compliance with industry on key changes.

Next, Kevin Durocher with ABB. Kevin joined ABB in June of 2017 as an environmental intern and began working full time in 2018. He's currently the Sustainability Program Manager at ABB. He focuses on sustainability within its operations, external reporting, and upstream and downstream operations. Kevin graduated from the University of Connecticut with a BA in environmental studies and a minor in women's and gender studies.

David Ocamb is the Director, Global and Environmental Programs for Trane Technology's Supply Chain and Operational and Service Enterprise Team. In his role, David's responsible for the environmental management and sustainability policies and procedures for the company's business operations spanning the global and industrial supply chain. David focuses on proactive environmental compliance management systems, business risks, mitigation measures, and direct and indirect improvements for the company's sustainability footprint.

Thanks to you all for joining us today. With that, I'm going to hand it off to Sean and Andrew with Chemours to kick us off.

Sean Uhl: Thank you Andrew. You can go to the first slide. Really excited to be here. We are from the Chemours Company, which is a chemical manufacturing company. And we have three main businesses that pertain to the discussion today: Titanium Technologies, which sells titanium dioxide; TSS, Thermal and Specialized Solutions, which sells refrigerant gases, foam blowing agents and others, so very relevant to the discussion; and then Advanced Performance Materials, largely sells fluoropolymers for many industrial uses, electronics. Also very relevant to key sustainability areas like green hydrogen and the semicon industry. You can go to the next slide.

What I'm going to cover is the decarbonization side, and then also a program level fluorinated organic emissions project. So like any chemical company, our decarbonization efforts are primarily focused in three areas: emission reduction, renewables, and energy efficiency. We have a goal to reduce our greenhouse gas emissions from operations by 60% by 2030, from a 2018 baseline, on our way to net zero operations by 2050.

Today we're going to focus on the emissions reduction part of that. And then specifically within that, the fluorinated organic emissions reduction project, which we have a goal to reduce 99% of our fluorinated organic emissions by 2030. And today we'll largely focus on the air, which is most relevant to this. Our goal covers anything with a fluorine-carbon bond, which means that they are all greenhouse gases and relevant to emissions reduction. You can go to the next slide.

So this again is on our fluorinated organic emissions reduction project. And I think the first thing that we really focused a lot on and was instrument to success was working on analytical detection capability for you know, both air and water. That really set us up well to develop what was our first roadmap on how we would reduce emissions in this space.

And one of the first things we did was put in place principles on how we would do that, and how we would build the roadmap. And with this, our very first principle and the first thing that we always try to do, is you know, how can we recover the emission for recycle or reuse, a circular reference. You know, once you've gone to the trouble of creating a chemical compound, it's much better to reuse it than destroy it or certainly to emit it. So it's always our first principle.

The second, if we're not able to do that, is we seek thermal destruction of the fluorine-carbon bond, and then recovery of the fluorine. And if we're not able to do that, then we would capture the fluorinated organic for a later thermal destruction step, is the approach that we took.

And so we took this analytical detection capability, these principles behind a roadmap, and put together what was the original roadmap for this work to begin to close the gap to 99%. And that ended up being a very important part of the exercise. It not only gave us a lot of really important projects to get started and you know, make meaningful progress, but I think also just as importantly, identified where we had gaps and technology, and how to meet that 99% goal so we could get started in studying some of those.

To date, we've made quite a bit of progress on these. We've completed 25 projects with an additional 11 that are currently in progress. We've achieved more than half of our goal, more than 52% at this point. And many more in progress to get past 70%. To date, the decarbonization impact of this work has been significant. We estimate that we've saved more than three million metric tons

of CO2e from this program, so it's something we're really proud of.

Next slide, I'll briefly cover the technologies before handing it off to Andrew. The technologies we use, and I'm just going to cover the air space here, is for direct thermal destruction of concentrated fluorinated organics. When we have streams like that, we have technologies that can achieve fours, six, nines plus of destruction efficiency. We also use adsorption in the case of where we have more dilute vapor streams that contain higher boiling like constituents.

Another important part of the journey has been more advanced fugitive emission detection and controls. You know, we've learned to develop and work with an optical gas imaging technology that's been very helpful I think to our manufacturing teams and operators, and you know, looking and finding for small leaks or fugitive emissions that can be corrected quickly, and that's been a big part of our success.

And also I mentioned we had a lot of development areas. And one of those is where we have, if we have dilute, very dilute vapor streams of high volume air that contains low boiling type constituents, and that's an area of development for us that we're working on today.

So that gives you an idea some of the technologies we use in the air space. At this point I'll turn it over to my colleague Andrew, who's going to start talking about the transition to lower GWP refrigerants.

Andrew Pansulla: Thank you, Sean. And good afternoon, everybody. So while Chemours is an end user, we also have a large group working on next generation refrigerant development. So in this section we will touch on some of the regulations, our refrigerant roadmap, and how some end users are approaching ways to find lower GWP alternatives to incumbent HFC gases. So if you'd go to the next slide please.

So there will be a presentation later in the webinar that covers more of the specifics on the regulations, but at a high level, I wanted to set the stage of what's happening on a federal level. And there's really three key pillars to the phasedown of HFCs.

So Andrew at the start of the presentation shared the phasedown map, so that would be the production and consumption allowances

for producers and importers. So over time, it's a quota based system where higher GWP gases, so things like 404A, really consume the most quota. So as we phase down and as end users are going to become compliant with those regulations, it's really going to require the enablement and use of lower GWP gases than the HFCs that are used today.

One of the ways that will be enacted is with global warming potential limits by application. So what's going to happen, and it will be covered in more detail later in the webinar, is you'll find that there's GWP limits and compliance states by application. So chillers will have its own compliance dates. HVAC will have its own compliance dates. And each one has GWP limits that's really based on what products are available today to meet those applications with lower GWPs.

And then there's a third phrase of it around refrigerant recovery, reclamation and reporting. And those proposals are being evaluated by industry today. And I would imagine next year we will see some more firm guidance as to what reclaim is going to look like in the future state.

It's important to note too that this rule does not restrict the continued use of existing systems. So there could become a point where it makes sense to retrofit. But the rule itself is more around new equipment and transitioning to lower GWP gases. Go to the next slide please.

So this is a refrigerant roadmap meant to be pretty high level of how we as refrigeration engineers view the industry. So we split it out into low and medium temperature refrigeration. Air conditioning with R-22 type pressures. Air conditioning with 134a type pressures. And then air conditioning with 410a type pressures. Then there's also low pressure chillers.

So on this slide you can see some of the installed HCFC or HFC's, many of which if you've worked with refrigerants, you're likely very used to seeing and working with, such as 22, 404a, 507, 407c, 134a. All of them have different GWP limits. And then in most cases, there will be a lower GWP retrofit gas for that equipment.

So this type of, these types of refrigerants are really meant to extend the life of the existing equipment and then become a powerful lever towards lowering greenhouse gas emissions. A retrofit from 404a to 449a for example can reduce the GWP by roughly 60%.

The orange or the reddish boxes are A2L refrigerants. So in the refrigerant world, you're going to hear more about A2Ls. So it's an ASHRAE flammability rating for mild flammability. So these refrigerants will be for new equipment only, and they will mostly be used in the next couple years, depending on the phasedown timelines for the different applications.

One of the ones that I do like to highlight is for 410a for example. 454b with the GWP of 465 is really going to become one of the main replacements in the air conditioning for new equipment only. Existing equipment will still need to operate on 410a, but new equipment will have lower GWP options available. If you go to the next slide please.

So real quick, we did want to show some practical examples of how end users are transitioning to lower GWP refrigerants, or lowering their total emissions in this case. This was a supermarket that actually installed one of the more recent transcritical CO2 designs. And over time when that system reached the end of its life, they replaced it with 454a and saw energy savings of roughly 34%.

You know, this gets into a larger topic around scope 1 and scope 2 emissions that's really important to be mindful of when determining refrigerant selection, because it really, as we move to lower GWP alternatives, it becomes important to really look at not only scope 1 or direct emissions, but the scope 2 energy consumption as well can have a very big impact on large refrigeration systems.

In this instance too, with A2Ls, we have increased leak detection. So in this system specifically, the refrigerant leak detection was below 3% per year. When you think of supermarket refrigeration generally, you see leak rates around 20-25%. So with the transition to A2Ls, you are starting to see lower leak rates and higher energy efficiency, which creates a whole savings in this instance of almost 30% total warming impact reduction. So would you go to the next slide please.

This is a simpler case study where this was an existing 134a chiller at the Pepsi Center. So, this was an ice rink. So prior to the start of the 2019-2020 hockey season, Pepsi Center chiller 1 was converted from 134a to 513a, or XP10. And one of the reasons I wanted to bring this case history up is to really show an example of how you can quickly and easily use your existing equipment and get lower

GWP impact.

Because other than the refrigerant change out, the only changes made to the system were upgrading the controls to 513a and a compressor lubricant change. So this end user was able to use their existing infrastructures and get roughly a 60% reduction in GWP, with effectively no change in kilowatt per ton between the two chillers. So we go to the next slide please.

A2Ls in the U.S. are starting to come out to market. I would say in the next year or two, you'll likely start seeing a lot of different field trials with A2Ls. For refrigeration, UL 60335-2-89 and ASHHRAE Standard 15 are going to provide guidance on how to safely install A2L refrigerants in refrigeration applications.

If I could provide just a one sentence guidance of what's important to look at there, it's understanding occupancy. Are you industrial occupancy? Are you commercial? Charge sizes and what mitigations are required, is really key to having a successful A2L installation.

In the case for this, this was a cold storage warehouse. Data is actively being monitored to benchmark performance, but overall this was really one of the first field trials of a system that was using a GWP less than 150 refrigerant in a refrigeration application. Overall system COP of 3.9 is pretty good for this application. So it's a good in-field example of an A2L being used.

So if you could go to the next slide please. Okay, Thank you for your time. I will hand it off to Kevin.

Andrew Whitlock: Andrew, Sean, thanks so much for your presentation there. Yeah, Kevin, take it away.

Kevin Durocher: All right. Hi everyone. Next slide. We're going to dive right in. So before we start talking about some of the fluorinated gases and our operations around those, I want to give you guys just a brief overview of ABB's overall sustainability strategy. Next slide.

I think giving you guys some information around some of our decision-making and why we're looking at some of these high global warming potential chemicals and compounds that we're using, and how some of those, some of that strategy structures our decision-making around those. So, next slide.

So we are really focused as a company on lowering our overall

emissions portfolio. Very focused on scope 1 and 2. And we're, we've signed on to quite a few different global structures for those commitments, and so we follow the EV 100, RE100 and EP100 standards for those. We also have an 80% reduction target for scope 1 and 2 emissions by 2030. Next slide.

And some of the ways that we're doing that is through various means. A lot of you guys are going to be thinking about green electricity, switching to renewables. But really scope 1 is where we're going to see the most challenge. And I think a lot of the other people in our industry, for all of you guys out there using natural gas.

Anyone using district heating. Anyone that has any direct emissions in that scope 1 portfolio, including fluorinated gases, that's really where a lot of the challenge is going to be. You can't just call your utility and switch over to a renewable version of natural gas or directly replace some of these fluorinated gases. Next slide.

So when we're talking about reducing those fluorinated gases, again scope 1 is really where a lot of our challenge is going to be. So that's really where our decision-making started, looking at what are our largest sources of scope 1 emissions? And how can we start reducing those, or eliminating them entirely? Next slide. And next slide.

As SF6 gas, sulfur hexafluoride, at the beginning of the meeting you guys saw it was the one outlier all the way to the right side of that chart. SF6 gas is the strongest known global warming potential compound known to man, currently. It is the same as, so for one kilogram of emission of SF6 gas, it is the equivalent of 23,900 kilograms of carbon dioxide.

So obviously that was a huge focus for us as a company, looking at where can we eliminate the use of this gas. In our process, unfortunately it is a very, very good compound in products, especially in electrical equipment. So our company uses it in our medium voltage switchgear here in the U.S. And so it is very, very efficient at reducing, or increasing the efficiency of our product, but at the same time it also is, works as a spark suppressant. So making the product more reliable and safer over time. But there is that alternate tradeoff of you know, what happens when this compound is released into the atmosphere.

I do want to note that the emission of SF6 gas and the use of SF6

gas are two different things. When it's sealed and contained correctly, when you can eliminate the emission of SF6 gas throughout the process of producing this equipment, that's where you're really going to see the majority of your actual scope 1 emissions being reduced.

The actual amount of SF6 gas going into the product is actually very, very small. You know, we're talking about 1000th of a percent of the actual product's volume. It's essentially just displacing the oxygen within the product itself. But at the same time, we also really started looking at what are some of the alternatives to the process itself, to eliminate the actual emission of the molecules. Next slide.

So, when we started looking at what are ABB's global targets, and how can we reach those targets, really eliminating that emission of SF6 gas at our Pinetops facility in North Carolina was kind of at the top of the list of priorities for us. Next slide.

Which I believe is our Sankey diagram. So this is a, just an overview of our emissions as a company in the U.S. And you'll notice that at our baseline year of 2019, the purple line there of Pinetops, their SF6 gas emissions, made up 15.7% of our company's total carbon footprint.

At the time, this was one site out of I believe 85 reporting sites we have here in the U.S. And so making up 15.7% of the time was obviously a great way for us to say hey, there's a problem here. We need to put a lot of focus into this to look at what we can do to eliminate that.

When we moved forward to when the actual project was completed or initialized, which was around 2021, at that time this emission of SF6 gas was actually 17, a little bit over 17% of our total portfolio. Next slide.

So the solution we found was a complete capture system. So the way that the gas is actually used is, previously it was the product was put into a vacuum chamber. The vacuum chamber was sealed. And all of the oxygen and air molecules was pulled out. And then a valve would open, and SF6 gas would fill the entire chamber.

And then the product was sealed inside, so that any air that used to be in all the small little spaces was now replaced with SF6. And at that time, the door to that vacuum chamber was just opened. And all of the SF6 gas in the chamber would spill out onto the floor,

and then it would be evacuated out of the building through some HVAC equipment.

It is important to note that SF6 gas is nontoxic, which is also another great benefit for it. What's funny is, if you actually breathe it in it will make your voice really, really deep. It does the opposite of what helium does. But we were always still focused on that environmental side of the use and the emission of it.

So this capture system from DILO, D-I-L-O, was specifically designed around our process. And it was specifically designed for the capture and reclaim of that SF6 gas. Once it's actually, so essentially it spills onto the bottom side of that vacuum chamber. Instead of the SF6 flowing out into the building, it would be pulled down into a containment system and it would be sensed. There would be a number of sensors for the level of purity of the gas.

If it was a high enough purity, which is at, I believe if it was above 98% purity, we would reuse and recycle that SF6 back into the top of the loop of our process. And if it was not pure enough, we would keep it bottled and actually ship it back to the manufacturer for them to recycle and reuse. So not only are we reducing the amount of SF6 that we actually have to buy, but we're also eliminating how much we're remitting overall.

So helping our manufacturer with sourcing virgin products for SF6. They're actually able to use a lot of the gas that we sent back to them, where they just put it through a filtration system, where they can get that purity back up and they're able to sell it again. Next slide.

So the results. The end of 2021, the system was installed and up and running. Throughout the entire year of 2022 we were able to see a 97.99% reduction of SF6 gas emissions, compared to the prior year. And this resulted in around 50 million kilograms of CO2e being removed from our scope 1 portfolio.

So it was an amazing success, and we're super happy with the product. And the DILO team actually has a full maintenance schedule with us where they're monitoring the performance of this system remotely. So at any time, if there's any issue or something like that where we're noticing some of these percentages going down or a possible leak, they'll actually reach out to us to notify our team. Say hey, we need to get a maintenance team in there to see what's going on. Next slide.

All right. So another thing that ABB does as a company. We use our air conditioning at all of our facilities and our offices, manufacturing sites, warehouses, et cetera. And with the use of refrigerants comes the tracking and the need to track the use of those fluorinated refrigerants, that all have a GWP value. Next slide.

So one of the things that we focus on really heavily as a company is making sure that we are collecting data from any possible source of greenhouse gas emission, whether it's scope 1, 2 or 3. And really doing our due diligence to analyze, you know, even if something might not be that material in the long, you know, the long run for our total portfolio, we try to encompass as many of those sources as possible.

And so we started introducing the requirement for each of our facilities to report any amount of loss HVAC refrigerant or what our company calls cooling agents, because our program was written by a European team. And there was some translation errors. But, so our cooling agent tracking was really, really key for us to start looking at and analyzing, where do we have HVAC leaks? Where do we need more maintenance?

And then also identifying where our facilities have some of those older classes of refrigerants, where we have ability to replace those with a more modern refrigerant and a more efficient HVAC unit. Next slide.

So we talked about refrigerants already. Obviously you guys are aware that they have both an ODP and a GWP, so that is a really big factor in why we're tracking them. Next slide.

I really wanted to just dive into some of the data reporting side and the importance of how you're collecting that data. So when we are calculating the actual greenhouse gas equivalent of these lost refrigerants, we're asking our facilities for essentially three different parts of data.

One is, what type of refrigerant exists onsite, and what is in the system. What is the amount being lost during each quarter. And then also, what is the specific GWP value of that refrigerant. So all of those three numbers combined gives us a really, really good data set and a level of analysis for knowing how much we're actually losing, in terms of emissions of greenhouse gases. But it also helps with our maintenance teams and our, so our project selection, essentially, for where we need to install some new systems that are

more efficient and use more modern refrigerants. Next slide.

We also did the same thing. Oh, this is just a quick screenshot of what those forms look like for our facilities. For anyone on the call that's looking to develop some kind of tracking or reporting system specifically around some fugitive emissions or any of these fluorinated gases, this is something that you know, you can take a look at. Next slide.

We also did the same thing with our SF6 data. We're essentially using a mass balance reporting where we're knowing how much and we're tracking every single molecule of SF6 that's being delivered to the building. And also what amount in stock exists at the beginning of each reporting period. And then we're essentially subtracting any kind of SF6 that's being stored at the stie at the end of the period, any amount that's going into the products themselves, and then also any SF6 that's getting sent out of the building back to the supplier.

And when you take that approach, we're essentially accounting for every single molecule of SF6, whether it's being used in the process. If it's sitting on a storage rack. Anywhere in the building that it exists, we're able to know whether or not there was any loss to atmosphere. So I think that's the last one I have. Next slide.

Oh, and then here's just that mass balance, that diagram there, for our reporting. I think that's it.

Andrew Whitlock: Awesome. Okay, thank you so much, Kevin. Great presentation. So before we move on to our last presentation, quick reminder. Please send questions that you have for our panelists to slido.com. The event code, #DOE. I'm looking forward to taking those questions at the end. So now we'll hear from our final speaker. David, go ahead and take it away.

David Ocamb: Thanks, Andrew. Can you hear me?

Andrew Whitlock: Yeah, coming in clear.

David Ocamb: All right, thanks. Let's jump onto the next slide. And good day everybody. I'm Dave Ocamb from Trane Technologies. Again, let's go on to the next slide please.

So real quick overview of Trane. You know, we are the premier HVAC equipment manufacturing and service company. So we have commercial space, residential offerings, and transport related

systems. There's some of our logos and trade names. We'll go on to the next slide please.

So we're going to have a little bit of recycle of content. But just as everybody understands, there's been an evolution underway. You know, in fact there's a past before the past on the flowchart on the right. We all kind of started with natural refrigerants, hydrocarbons. And we'll probably find ourselves using hydrocarbons in the future, completely free of chlorides and fluorides and whatnot, you know.

The focus in my business space as a company that offers the building cooling systems and the process coolers, you know, we've been working on the transition for the redesign, thinking about the application and the operation where this will be used. 410a is our big refrigerant offering in recent years for particular commercial residential equipment, and that is being replaced with a new gas.

Again, we're partnered with Chemours and working with our 454b as the A2L replacement for 410a. And these gases and the systems have been tested. They've been around a while. But there will is some shakedown activities underway. And we'll cover some of the questions about dry up in here when we get to the end of my slides. But if we go on to the next slide please.

So again, it's just kind of a more pivoted presentation of this EPA AIM Act. You know, this is certainly a big deal for Trane Technologies. And it is an important consideration for any party that's buying a new HVAC system in the United States. So, you can see that there's restrictions coming on the GWP as we talked about earlier.

And the whole span of skating rinks and data centers and grocery stores and air conditioners. Window units and rooftops and chillers and foams. So you know, the EPA has got to bookend this. There's going to be a phaseout over these next number of years that you know, of course it goes back to the Montreal protocol and the learnings about, you know, the carbon potential of these materials that we use as replacements to protect the ozone layer. And of course we're phasing those out, and focused on the dual purpose of ozone safety as well as carbon consideration.

So there are requirements, kind of promulgated on the books. But I do believe that there are some public comments, some pushback. Maybe some lawsuits, you know. Some of this we think might be subject to change, but as a company that offers finished goods, this

is an important glide path for us to make sure we have our products aligned with the restrictions that are coming from the Federal EPA or other parties, so we maybe can see on the next slide.

So some of the states kind of jumped ahead. And in recent years there's been some flipflopping on the federal level of the SNAP rule, or the refrigerant regulations. And because of that, and of course with a general allowance where the states can always, can be more restrictive than the Federal EPA and their state level for other programs, we had 12 states move ahead with their own refrigerant restriction regulations.

And again, this is something we as a manufacturer of the finished goods, the HVAC systems, we've had to, sorry, a little bit of a cold this week. So we've had to work on our redesign and manage our sales and distribution points, It's a lot of interesting stuff. But these rules focus primarily on new equipment. And for us in the near term, it's chillers.

And there's a requirement in some states that after January 1 of this coming year, that we cannot sell the equipment with the older refrigerants in place. And again for us, that's really our 410a or our 134a. So if you're trying to buy a new unit and you're in those states, you're going to be looking at the lower GWP alternate gases and systems.

This is similar for California, Massachusetts. You know, they have a restriction on chillers starting January 1. But our friends took it a step further. And you have to have an approved building permit to install one of these new systems in your business, if that installation occurs after January 1. And again, we see that there's a lot of activity for public petition and comment and even perhaps litigation to get some of these measures, and trying to get alignment with the federal rules.

So be cognizant of where you reside, and what the restrictions are for your state for 2024, and what your allowances are for equipment to purchase. Next slide please.

So as we've talked earlier, the GWP, the new and improved items, in particular what we're looking at is the R454b at our residential and commercial offerings. So A2L was a low flammable material, so it is low. It's not like hydrogen or something that could self-automate or ignite I should say. But these are still technically flammable, and I think they're hard to catch on fire. But they can burn, right?

So we're now facing equipment going into businesses, commercial settings, eventually homes, that are going to have a low flammable cooling agent in the system. And certainly as an engineer, it makes me a little concerned. But there's been a lot of efforts on the manufacturer's side to install leak detection. You know, some automation. Some system management techniques, to keep the system safe and alert if there's a leak, or if there's an issue, so the operator can be aware of that and can react safely.

And something on here I didn't include, I should have added. But the building codes, there's a lot around buildings, the expectations that are for placement of these types of systems now that have a flammability risk. Because remember, it used to be just an inert gas. It used to be kind of an oxygen suppression risk that you could face. But not flammable, right? So this is new.

And then for again companies like Trane, if our manufacturing sites, so we have new measures in place. In fact, the supply tanks that we have at our factories, they've kicked us over the OSHA PSM standards we've had to put in place. We missed in the past. So one thing, I had the question on the poll about the service technicians. We've had to do enhanced training for our technicians.

And we work on commercial industrial systems, not residential. But we use the ESCO's Low GWP Refrigerant Cert program. It's a really good training system. If you are doing your own equipment servicing and you have A2Ls, I suggest you take a look at that program. It can help you.

And one thing in the past that locations are maybe guilty of on occasion is kind of running your equipment to failure, right? And in this future state, you really need to be sensitive to your O&M. Make sure you're protecting your equipment. You're looking for leaks. You're making sure it runs effectively. Safety first, right? So, next slide please.

So just real quick, from we as a manufacturer's side. We've been looking real hard as well, just like Chemours, like ABB. And our mission, our scope 1, is where the refrigerant carbon falls in. So a lot of work around our charging, our finished goods. Foam blowing. Looking at routine versus non-routine losses. We want to avoid an oops on a tank bedding, supply tank, and a big puff of, a big release of refrigerant. Look in our laboratories.

You know, even a BLC's going to put everything, this is a little bit of our recycle from previous fugitive emissions, TOE meeting. But that said, we also are looking at for leaks from our cooling circuits. Whether it's for process or comfort cooling systems. And this is a common, you know, leak point or emission activity for any Better Climate or Better Buildings partner. Next slide please.

So, we did have kind of a final site that we had a, you know, we called certainly a big win. But we had a past practice to use refrigerants as a tracer gas. We would look for leaks at our cooling circuits. You know, sounds kind of dumb, but we have a pretty good system to charge and recover. But yet, you would have leaks, right? And they could add up. And this is, again, you're looking for leaks. You're looking for a brace failure. And if you have a good size circuit and it's got charge, poof, there's a big emission.

So, we went through aid analysis. Worked with our equipment partners, our industrial gas partners, and we came up with the nitrogen/hydrogen and 95 mix so we're able to swap that out. So our last facility, they had some unique things, which is why we had to kind of its own investigation.

And it was a big, you know, scope 1 reduction for us. 34% reduction on sites fugitive. The first portion of operations was 14,000 metric tons of CO2 reduced. And of course it helps on productivity. It helps on reliability. You know, using refrigerants is expensive, right? Our carbon aside, it still costs money to lose that gas. Next slide please.

And you know, another thing that we're doing on the industrial side, is thermal imaging cameras. We use those to look at hard to access points, and look for heat signatures that suggest like a 410 release or something like that. We're managing better our pressure relief valves and our charging supply, you know, storage system, whatnot.

And that's been a big win. I've got some high tech stuff I'll show you in a minute. And of course a lot of work around our Managing for Daily Improvement combined with our electronic data management, charging, dispensing control systems, recovery, all that.

And looking at this stuff daily. That's the thing I could always suggest is, if you're paying a lot of attention to your systems and you're focused on carbon and leaks around a refrigerant space, daily is you know, it takes time but you're going to get the most

bang for your buck out of your management system if you look at it on a routine basis. So one more slide, please.

And here's my chuckle. We were having an issue with a site, with relief valves. And we put a high tech balloon on you know kind of some key valves here. And it's an easy visual. So when you think about your system, you know, one thing in all this for the refrigerant management is understand where your leaks are. What makes sense for your site, and how you can kind of keep it simple, concept as we all know.

So just this exercise has made a real quick visual indication of do we have a problem? If we're able to fix some valves and reset some valves, just by having a little leak that goes in a balloon. And prior to that it could go on for days before we would find it, right? Because you didn't have an older, things like that, so.

So anyway, there's certainly opportunity for both the finished users that in the offerings we have. And then we as a manufacturer, you know, this is an important space for us. So, next slide.

And there it is. So thank you for your time, from Trane Technologies.

Andrew Whitlock: Great, thanks so much, David. And thanks to all of our panelists for the presentations today. We're quickly approaching the top of the hour, so I invite all the speakers to turn on their cameras, and we'll jump into Q&A. Please go to slido.com and submit questions. Even if we can't get to them today, we will provide information and ask our speakers to follow up, to respond to your questions. So get those in.

Okay, first up, I have been told that heat pumps and other technologies that use one refrigerant cannot be switched to a lower GWP refrigerant. Is this true? What's the reason or reasons why? So, David, I'll defer to you. And then maybe –

David Ocamb: Yeah, let me jump to that one first. So I think you know, you start with, it's a case by case basis. And the nature of your equipment, the refrigerant you have in place. I think we had the Pepsi example that was really cool, that was, you know, pretty much a drop in. But you know, again, I'm an environmental guy that works in the sustainability space.

I've talked to some of my equipment designers, and for the 454b in general, it's not a drop in because there are the safety measures.

There can be some building standard requirements. It could be mistaken, whether that's the case across all the United States. But I think it's something that you need to have a qualified technical resource to help you look at your system. Look at your current state and planned conversion, and make a decision at whether you could do a drop in and what other ancillary measures, again like Pepsi, could be required to make it safe and effective.

Andrew Whitlock: Sean or Andrew, do you want to add to that?

Andrew Pansulla: No, I think that covered it well. Overall, if you're using one of the refrigerants that have the mild flammable classification, then that's for new equipment only. So in some cases, there could be retrofits that are available. But as David said, it's really a case by case basis of what products are available. In the case of 410a, which might be what this question was focused towards, yeah. 410a will only be used with 410a equipment. Because there's no retrofit gas for 410a that's nonflammable.

Andrew Whitlock: Great, thank you. Move on to question two. Do gas manufacturers monitor solid state refrigeration technology developments, such as magnetic refrigeration mentioned by the Daichin CEO in an interview in March 2022 to Bloomberg? Are any of my speakers familiar with that, or do you monitor these technology developments?

David Ocamb: Trane'll go again real quick. We are certainly aware of the technologies out there. And as I said earlier, there's some other refrigerants that might be further down the pipeline for us all. And we're trying to find the greenest solutions with a reasonable transition once all the technical aspects are confirmed as effective and manufacturable and things like that. So I'm aware that we're looking at some what I'll call, some newer state. But some of it actually is old technology that might be repurposed, right? So that's part of what our tech team is working on.

Andrew Whitlock: Great. Moving on to the next one. The slide being shown makes it sound like retrofits can occur, and Andrew, I'm going to assume that this was on one of the case studies. So maybe you can speak to how this is done, new linesets that are required, et cetera.

Andrew Pansulla: Sure. That's, there's a lot of different retrofits out there at a high level. If i had to give guidance as to what needs to be done, I would look at the key components and the sizing, and see if there's a lower GWP alternative that really had the same pressures, mass flows, efficiencies, as the incumbent gas, but with the lower GWP.

Yeah, people are doing retrofits all over the place. And you know, key focus areas are cycle performance, looking at TXV sizing, lubricants, elastomeric seals. There's retrofit procedures available for pretty much any application today. So yeah, usually you're not changing onsets. But in some instances, depending on what you're looking at, that could be considered.

Andrew Whitlock: Fantastic. Thanks. Kevin, I'm going to toss this one to you because of the refrigerant management practices that you all have implemented at ABB. So for non-industrial partners, what would you suggest as the most important first step for GHG reduction related to fluorocarbon gases? Retrofitting, targeted HVAC electrification?

Kevin Durocher: For the general use of refrigerants really the first step is knowing where you're using it, how much is being used, and then what types. So for us, really building a pretty in-depth data collection program is really the first step. When we're looking at how to target different facilities for retrofits, new efficient, more efficient technologies, really looking at especially for roof mounted HVAC, where we're doing roof replacements. When we're doing any kind of work or construction on the building, that's the prime example of prime opportunity for us to, if we're removing all the equipment off the roof, let's replace it with something that's better. So that's really where our top of the priority list is.

David Ocamb: And Kevin, I would add to that to, I agree with all of that. And one of the things that in a past life, what we did is we made sure we had a full sum inventory of all our refrigerant charged equipment. We knew the age, the manufacturer, the gas. And kind of start planning, and look at that. The allocation reduction is when are you going to start seeing a hit on the cost of your replacement gas. So a lot of pieces there. But certainly start with an inventory of all your equipment with the associated specs.

Kevin Durocher: Uh oh. Andrew might be frozen.

David Ocamb: I'll jump to one of the questions here. The manufacture of HFOs, I'll say for the replacement A2Ls. Again, Chemours is manufacturing the material. And we've retrofitted some of our facilities. And we have product offerings right now. Other companies like Trane have product offerings. So this stuff is out in the marketplace. And if you have you know, a tired system and you're thinking about a swap, certainly you're going to get the opportunity to look at the 454b's or the A2Ls.

And recognize that the companies like Trane, we're redesigning these systems to be more energy efficient. We have our own commitment to customers to reduce their carbon. So both the refrigerant change and the energy to operate. All that's going to be a great offering for whomever you have a partner for supply.

And it looks like we're closing out. We lost our DOE host. Look at all the webinars coming. I feel like I'm a spokesperson now. Good stuff.

Female Voice: Okay, thank you everyone for your questions, and to our panelists for the insightful responses. This webinar is part of the 2023-2024 Better Buildings series. As you can see, we have a great lineup for presentations through March. Visit the Better Buildings Solution Center to learn more and register.

Next p we have the December 19 webinar titled Storing and Saving: Using Thermal Energy Storage in Commercial Buildings. Join this webinar to learn more about thermal energy storage and gain insights from example projects exploring this opportunity.

We are pleased to announce registration for the 2023 Better Buildings Better Plants Summit is now open. The Summit will be in the heart of Washington DC April 2-4. In addition to engaging in interactive sessions, attendees can look forward to plenty of opportunities to network with their fellow industry peers and experts. Explore the session tracks and book your accommodations on the Better Buildings Solution Center.

The Better Climate Challenge Road Show Cleveland edition is here. Watch now as DOE energy experts visit several of the Better Buildings and Better Plant Partners to see how organizations are putting decarbonization strategies into action. From Cleveland Cliffs to city of Cleveland and Cleveland Clinic, these industry leaders are making major headway in emissions reduction and sharing strategies for others to follow suit. Rock on and tune in to the full series on the Better Buildings Solution Center today.

With that I'd like to thank our panelists very much for taking time to be with us today. Feel free to contact our presenters directly with additional questions, or if we couldn't get to your questions during the Q&A period. I encourage you to follow the Better Building Initiative on LinkedIn or Twitter for the latest news. You can find our handles by their respective icons on the left half of the site.

You'll receive an e-mail notice when today's recording, slides and transcripts are available on the Better Buildings Solution Center. Thank you, everyone.

[End of Audio]