Holly Carr: Hello, folks. This is Holly Carr at U.S. Department of Energy. Thank you for calling in and joining the webinar today; focus on advanced refrigeration.

As many of you know, advanced refrigeration was one of our priority topics for the retail, food service and grocery sector in the Better Buildings Alliance this year.

We have everyone on not on mute. So all of our attendees are open on the line. If you are not speaking, I would encourage you to go ahead and mute your phone.

We do want to try to leave the lines open so that later on folks can just ask questions over the phone, rather than typing them into the webinar interface but we'll see how that goes.

And yeah, so this is one of our focus topics for the retail, food service and grocery sector with I believe as Jim McClenda had put about the summit last year, the LED of refrigeration; kinda where is that and what's coming down the pike and what can retailers and food service folks be looking for in terms of technologies.

What's the research that EOV is doing and other trade organizations, and manufacturers and so forth, and what are the latest developments in refrigeration?

So this is one of our first efforts to address that priority this year and we have some folks on a panelist, next slide please and we'll see some visuals.

All right, so our first presenter is Tony Bouza. He's right down the hall from me here at the Department of Energy and he is the technology manager in our emerging technologies group.

Tony is going to be talking about kind of the research strategy in refrigeration here at DOE and then giving you some examples of some specific projects that he has managed recently, as well as some opportunities both domestically and internationally to get involved and participate in this research.

Then we'll move on to Michael Deru who is a researcher at the National Renewable Energy Lab. Michael is gonna be focusing specifically on motors and condensers in refrigeration, and give us some highlights from recent research there, and then finally we'll have some comments from Daniel Wright who is the Executive Director at the North American Sustainable Refrigeration Council.

Daniel is gonna be covering alternative and low GWP refrigerants, and a lot of the work that NASRC is doing to promote those refrigerants here in the U.S. and beyond but we're focused on the U.S. So next slide, please.

With that, I am going to turn it over to Tony. Please, as you have questions you can either type them into the webinar interface and we'll keep track of them but I will open it up just for a few minutes after Tony's comment.

If you have some questions specifically for Tony, you can unmute yourself and just say them, ask them. All right, Tony?

Tony Bouza: Thank you, Holly. Like Holly said, I'm Tony Bouza. I'm with the Emerging Technology Side of the House of the Building Technologies Office and I'm gonna be talking about DOE's refrigeration research strategy and opportunities to collaborate.

I view this presentation not so much as a deep dive on any particular topic but a major introduction to see how we can work together and deploy some new technologies but at the same time help me guide some future R&D collaborations. Next slide, please.

So what is DOE's HCCNR specialty with refrigeration strategy? Our main strategy is we're an efficiency first organization. So you know, the first things that we always look in our short term, mid-term or long-term strategy is energy efficiency and this strategy can be divided up into these three parts: in the short term, we're developing and evaluating low GWP alternative refrigerants, including the characterization of climability and also looking at hot climate performance that is very directly applicable to refrigeration systems but it's also critical in the HVAC side too.

The mid-term, we're looking at systems that can handle these low GWP refrigerants and we like to say that's energy savings with tomorrow's technologies.

You're still using refrigerants but you're using them in new ways and sometimes that could be new compressor designs or new systems that are still using refrigerants but with a different configuration.

But our long-term strategy is the development of non-vapor compression systems, systems that move away from using a GWP refrigerant at all.

So these technologies are a little bit next generation and they're a major departure, and that's why they fall into the long-term. To be realistic with you, these are technologies that may be out like 10 to 12, to 15 and for some applications even 20 years out into the future.

But as the government, we take a higher level risk and these are the initial investments in some of these technologies, but overall we're looking at technologies that are focused on an efficiency first drive. Next slide, please.

And we rely on many – our strategy focuses on first we have a solid foundation where we rely on a lot of technical reports. So over the years we have commissioned Navigant, and Bill Getzler and Navigant is an excellent team to write several reports, and some of these report do focus in the commercial space.

It's been a while since we did a commercial refrigeration report but in the future we hope to, and this is like one opportunity that we use as an input because we know that our – financially, our resources are very limited.

You know, budgets go up and down but technical reports are an ideal way to fund an opportunity to be able to tell to the marketplace look, these are the opportunities that are out there and leverage the resources that other people in the marketplace may be able to read and say hey, these are the challenges from maybe Nyserta, California or even people within the DOE organization.

So these technical reports then feed into funding opportunities where we directly fund R&D at the national labs and you can see the whole list of national labs that are across the whole U.S.A.

So we're not just focused on one or two but we try to fund, depending on the opportunities we utilize the whole portfolio of all of these excellent resources that the department over the years has invested in, but we also rely on the private sector and universities to help us fund this R&D agenda.

At the same time, we also being a government organization, we also undertake a lot of international activities where we leverage the resources from others outside the U.S., and their skillsets and their knowledge sets, and we help influence projects that we can coordinate with them and learn from them.

Because one of the things that you realize first is sometimes we're not the leader. Sometimes we may be following the lead of other countries in some areas.

Next slide, please. Oh, thank you. You know, one of the things that we try to focus in the emerging technologies, at least in my portfolio, since it relates to HVAC and it relates to refrigeration is we try to look at – when we fund R&D we definitely don't do basic science, since the Office of Science does that work.

So we rely a lot on low TRL levels, sometimes as low as three or two, you know, to do R&D with.

Holly Carr: Tony, just –

Tony Bouza: Hello?

Holly Carr: Tony, just to jump in on the TRL, that's technology readiness level.

Tony Bouza: Yeah, TRL.

Holly Carr: So low TRL levels are basic science. High TRL levels are more closer to market-ready technologies.

Tony Bouza: Correct. So in many ways I'm like maybe people that have interacted with our base in the building technologies, I sort of nurture technologies at a very low level to even very close interacting with manufacturers to deploy these technologies.

So we may have – a good example was with the Recovery Act. During the Recovery Act, we funded a project with General Electric where magnetocaloric materials were used for refrigeration.

So Ge was mostly focused on the material side, and then later on that project grew into a CRDA, Cooperative Research Development Agreement where GE didn't get any money from us but they received the skillsets to help derest that technology to the next level where more of a systems approach was done, and we hope in the near future for that technology to make it into the marketplace.

But an important part is that we're more than just working with researchers in the lab. We always try to work with manufacturers, people that are able to bring these technologies into the market.

Historically, most of our portfolio and even though I'm gonna give some few examples that worked in the commercial space, historically most of the strategy has been used just in the residential site.

So I'm looking forward to post this webinar to build strong relationships inside and be able to deploy more technologies, not only in the residential but in the commercial space.

Next slide, please, and these next two slides are gonna be related to two examples that the portfolio have funded historically. The first one is with Hill-Phoenix, and the Hill-Phoenix system focused on a CO_2 supermarket refrigeration system.

But the main take-away from this is two things. First, we worked with an industrial partner. We helped them bring this product into the marketplace by testing.

Second of all, we used a low GWP refrigerant, CO_2 but we also have you know, the energy savings associated with these systems. You know, I know that in previous calls there were talked about these systems not performing or being systems that consume energy, that actually were not resulting in energy savings but that isn't the case when they're properly designed and sighted.

And at least in the lab, we were able to demonstrate these energy savings and also deploy them in a few sites in the U.S. and they're more of a – I don't know the exact count as of today.

I know last year there were at least a dozen of them but today there's more up, but we rely on market leaders like Hill-Phoenix to help us leverage the resources that we have at the national lab and bring some of these technologies into the marketplace.

But in my portfolio and since I work with earlier stage, usually once that product comes into the market, usually that ends my role but I'm always looking at hearing input from others where case studies can be performed, or to get a feedback loop on what are the challenges that need additional R&D that needs to take place. So that's one of the outcomes.

Holly Carr: Tony?

Tony Bouza: Yeah.

Holly Carr: Sorry Tony, I'm gonna jump in real quick with some acronyms for folks. BTO is the Building Technologies Office here at BTO or here at DOE, and FOA is a funding opportunity award. So those are projects that are financially supported.

Tony Bouza: Yeah, I do apologize for using --

Holly Carr: *[Laughter.]*

Tony Bouza: Yeah, I do apologize for using the governmentese language.

Holly Carr: Just keep sending us notes when you have questions about acronyms. Back to you, Tony.

Tony Bouza: Yeah, next slide. So that was one example where we were using – working with a major partner but we also do – have done a lot of work in the refrigerant side with actual refrigerants.

Historically, the program has been very strong in working with NIS, the National Institute of Technologies where we did a very lengthy survey of potentially what kind of refrigerants were out there, and you know, so in many ways we were able to narrow down the universe to a couple of promising refrigerants and that was one part of the portfolio where we worked on something that was very much early stage.

Working with Honeywell, you know that gave us the opportunity to work with an industrial, with a major refrigerant producer to come up with a refrigerant that actually is a very good drop-in replacement.

Often, there are no silver bullets. There are really very few opportunities where you can actually replace one refrigerant with another, without doing major redesigns.

This is one of the few where it's a potential drop-in replacement. As you can see, not only is it a low GWP global warming perspective as a reduction but there's also – it creates an energy saving potential compared to the refrigerant 404a.

So it's very important to realize that everything that we do is always focused on the energy savings. Next slide, please.

Holly Carr: And Tony, what are the approximate energy savings from a 404 to what is it, 448 refrigerant switch?

Tony Bouza: Yeah, the one that was 10 percent. I have it in the bullet at the bottom.

Holly Carr: Okay, thanks.

Tony Bouza: Yeah, so the energy savings were somewhat modest but it is a drop in replacement. So that gives you the opportunity to tell you that in many ways there are no silver bullets.

You know, there are definitely more energy savings to be gained if you are able to modify the whole system and change out, but we know that entails major cost impacts, and it's not an option that maybe all commercial refrigeration sites will be able to entertain.

One other aspect, and this is related to IEA annex 44 where we did – when I say we, the International Energy Agency worked on performance indicators for energy efficient supermarket buildings.

But the main take-away that I'm presenting this as an example wasn't because of the outcome of this R&D project but it's just to demonstrate the potential that – you know that the building technologies office, through the IEA is able to entertain projects in the refrigeration space, not only from the U.S. but from an international perspective.

The U.S. was not a participant in this IE annex because we were not able to find U.S. participation to participate in this R&D focused effort but in the future, this is something that people in the call are able to come up with R&D projects that they believe may have some merit from – or could benefit from an R&D perspective, using a group of international researchers.

The IEA HEPA program, you know, most of the participants or member countries come from Europe but it does include a few Asian countries like Japan and Korea that are very active.

So it gives us the ability not only to do R&D that benefits the U.S. but the Europeans in many ways, especially with some next generation refrigerants are somewhat ahead of us.

And you know, if we are able to propose and this is where this call can act as a catalyst is that if people have ideas or concepts, you know, that's something that the DOE can bring up and formally propose a topic and actually see if there's any interest from the IEA member countries to pursue an R&D agenda, and this annex was just an example that supermarket and especially commercial refrigeration is something that – you know, there are a lot of member countries that are very much interested.

And you know, one of the major outcomes was to use energy recovery on a supermarket refrigeration system that was one of the final report outcomes. I had put in that quote to identify one major outcome.

You're more than willing to – there's a link at the bottom to actually read the report and see some other outcomes from these metrics that were developed. Next slide, please.

Yeah, and you know, so you heard a lot of things that I went over, things that we have accomplished, things that were going, that we're gonna do and these are some active activities on work at Oak Ridge National Lab that we're doing right now.

So we're pursuing R&D efforts right now on defrost technology, novel designs of compact flooded evaporators for commercial refrigeration applications.

We're also looking at magnetic refrigeration mostly in the residential side but it could be applied in some small scale to commercial units. We're also looking at expansion losses and commercial refrigeration systems, and one of our major efforts at this time, even though it's focused on HVAC side, we're working with ASHRAY and HRI is determining safe charge limits for flammable refrigerants, both A2L and A3 refrigerants.

Even though we're starting out in HVAC we hope in the future to do similar activities in the commercial refrigeration space. Next slide, please.

Holly Carr: Tony, quick acronym question?

Tony Bouza: Yeah.

Holly Carr: What does the HTP term refer to? Is that – HTP, I think it was maybe two slides back.

Tony Bouza: Can you back-slide? I wanna see HT – because that's the HT Pump. HT Pump, which one?

Holly Carr: Back one more.

Tony Bouza: The previous one back. Back slides, previous slides.

Holly Carr: Sometimes it takes a minute to go back one. There we go.

Tony Bouza: Oh, okay.

Holly Carr: HTP in the quotes, in the red text.

Tony Bouza: Okay, Heat Pump Technology.

Holly Carr: Okay, thank you.

Tony Bouza: Yeah.

Holly Carr: We can go forward two slides.

Tony Bouza: Sorry, yeah. Yeah, so how can you continue this initial dialog? You know, one of the things is we're gonna have an upcoming peer review where we're gonna do deeper dives in some of these projects that we highlighted that are related to refrigeration.

So I wanna welcome everybody to come to the building technologies peer review. It's gonna be in April through May 4th. There will be additional information on the building technologies websites where you can register.

Normally, you know, part of those technical reports that historically have always commissioned Navigant and built that sort of team is that we do a lot of road-mapping exercises or we do workshop reports.

So if you are willing to participate, let me know and I can include you in those distribution lists. We also, like I mentioned, we're always looking for new research proposals to propose to the IEA annex but the term annex just means a project, focused on supermarket refrigerations to see what are people interested in and to see if they're willing, if they have resources on-hand or thereabout to start a project in a supermarket refrigeration system.

That's something that I can re-package it and try to submit to see if there's any way that that can be leveraged using other people's resources outside the U.S. and to see how their technologies or their approaches, compared to the technologies that we're approaching or using in the U.S.

And I want to close out with my email address. If you have any questions or wanna get a hold of me, you can always email me.

I'm always open to talk to anybody related to refrigeration, commercial refrigeration. That's something that the portfolio needs some strengthening and you got some of the subject matter experts that we want to leverage to the greatest extent possible. Thank you.

Holly Carr: Thanks, Tony. I just want to reiterate these invitations on this slide. These are real events that we would like our real partners out in the world who are using these systems, buying the systems, designing these systems.

We would love to have your involvement, either as a peer review or these roadmapping exercises. So please do put an action item on your list to reach out to Tony directly to me, Holly Carr, if you are interested at all in participating in the peer review or in any future technology roadmapping exercises.

Just so you know, we may not have those roadmapping exercises scheduled or on the books quite yet but we'd like to keep a running list of folks who are interested to be a part of those meetings when they do happen, and this is your opportunity to join a national team here as we dive into the Olympics, this season.

You can be a part of the – of the national team for HVAC and refrigeration, IEA's U.S. Team.

Tony Bouza: Yeah.

Holly Carr: So are there any questions from folks who'd just like to unmute themselves and ask a question before we move on? And I am getting a couple of notes from folks about signing you up for roadmapping and support. So thank you for those. Just keep them coming.

All right. With that, let's move onto the next slide, which I believe is Michael Deru. Oh, and we do have a quick question, Tony, before we let you go.

Tony Bouza: Okay.

Holly Carr: What is a non-vapor compression system and what is the benefit of such a system?

Tony Bouza: Okay, non-vapor compression system is – and there's a – it's when a refrigerant is being used to provide this heat-pumping action. We actually have several technical people in the R&D world who may call it not in-kind technologies that may seem even more archaic or

– go ahead. It just means that we're not using a refrigerant, and the advantages are there's no refrigerant. So by not having a refrigerant, its global warming potential is zero with the direct.

The efficiency still is an important part. So we want to – and the advantages, also a lot of these are solid state. So they can also give you partial load – potentially partial load performance and other benefits but they are our long-term.

So instead of manufacturing is going through several refrigerant change-out, the ultimate is getting refrigerants out of the equation completely. That's the end state. That's why it's our long-term strategy, the end state but you know, it's gonna take a long time before we get there.

Holly Carr: Great, thanks Tony. We also have a question about any upcoming requests for a proposal and that's really not something that we can talk about on this call.

Tony Bouza: Correct, yeah. Sign up for the BTO's, the building technologies have a little email where you can sign up to get updates about the office and future funding opportunity announcements in general.

Holly Carr: Okay, thank you so much, Tony. We have some additional questions. I'm gonna go ahead and move on to Michael's presentation and assuming that we have time at the end, I'll come back to some of these questions for Tony, so don't leave us completely, Tony. All right, Michael Deru, you're up next. I'll just turn it over to you.

Michael Deru: All right, thank you, Holly. Yes, I was – this is Michael Deru at the National Renewable Energy Laboratory and I'm gonna talk about some testing we're doing on a new motor with refrigeration condensers. So next slide, please and just to recognize the team here myself, Fran Wheeler who is also gonna talk, help me present this today. He's here with me as part of the testing group.

I want to recognize our partners, Wal-Mart stores and Software Motor Corporation. Next slide, please and what we're talking about today is – it's an air-cooled refrigeration condenser and it's – usually, it's outside on the roof or sometimes on the ground in an enclosed area but it's a long – like a big radiator with several fans.

So sometimes you can have – in some cases, up to 18 to 20 fans, each with their own motor. In this case, we're looking at one and a half horsepower motors. So there's a close-up of the fan without the guard on it and then there's a picture of one of these banks of fans on an air-cooled condenser.

So in this case, go to the next slide please, and I'll just give you a little more background. On a typical refrigeration system in a grocery store, about 50 percent of the energy is gonna be a compressor and maybe 10 percent goes to the condenser fans, if you have a constant speed.

So one of the first energy efficiency measures you can put on it is to do – put BFE's. So that will reduce the – so when I – variable frequency drive on the motors and that'll give you some savings because you don't have to run those fans at 100 percent all the time.

So reducing that speed can give you significant energy savings and it's worked out pretty well for most part. So we're gonna talk about a little – a different type of motor today. So go to the next slide, and the really exciting technology because it provides a high efficiency motor that is in this larger size range.

So anywhere – right now this company, Software Motor Corporation has motors from the one to 10 horsepower and they are —you know from a construction standpoint, they're very simple.

The challenge is these switch-reluctant motors have been around for a long time but no one's been able to figure out how to really make them efficient and provide a smooth power curve.

And so a lot of that has been in the design of this rotor which is the high rotor pull, has more pulls on the rotor than the stater, and the – and the software control, being able to control these things very tightly, to control the speed and the torque and the vibration, and provide a very smooth transition.

And as I said, they're pretty simple. So there's no permanent magnets in here, no rare earth materials, which makes them inexpensive to manufacture, compared to trying to make a large permanent magnet type of motor.

And go to the next slide please, and here's just a – and they're very high efficiency. So here's a – this is a graph from Software Motor Corporation, testing their motor against a NEMA Premium Efficiency Motor in both one-horsepower and you can see one of the greatest things, not only the high efficiency but the efficiency stays high across the speed range.

So even down at lower speeds, the efficiency stays high whereas you take that NEMA induction – NEMA premium induction motor and the efficiency starts to drop off more, and if you go below 600 that curve still continues down.

So the next slide, please and I'll talk about the demonstration that we're doing. So we took – we're working in a Wal-Mart store where we took, we have two banks, two air-cooled condenser banks.

One with 10 motors and the other one with eight motors and we replaced half of the motors, half of the high-efficiency induction motors with this high rotor pull, switch reluctance motor and doing side by side testing.

So the phase one is just taking the same control signal that's given to the induction motors and applying it to these new motors, and just comparing the energy consumption at the same speed.

And then phase two, which we – there's a future and with timeline to be determined but with the control of these motors, because they're – they really have – each motor has its own controller and communications and has a lot of intelligence built in.

We can do a lot of cool things and we can optimize the control of the condenser bank, and now we can think about well how is that going to impact the whole refrigeration system, and what are the energy savings opportunities that we can get by optimizing that condenser control, so that we can – and we'll talk about that more in a minute. I'll leave it there for now.

Go to the next slide and we're just gonna – I'm gonna turn it over to Grant now to talk about the results.

Grant: All right, so for t he results we're still in phase one, which is as we said before, as Michael said is a comparison, an apples to apples comparison. We're taking this induction motor with the VSC and we're comparing it to this HRSRM motor.

In the table, you can see based on 850 rpm for both motors, the legacy condenser system power was 1.04 kilowatts per motor.

I want to mention when I say system, the reason I wrote that is because this includes the inverter power into this and then it's averaged over however many motors are controlled by this one inverter. So the legacy, it doesn't necessarily need to be one to one. So in this case there were 10 motors controlled by one inverter originally.

And then for the HRSRM condenser system power, you can see the power drop there at promoter. It's 0.73 kilowatts per motor with a percent difference around 30 percent.

So once you're comparing apples to apples, you definitely can see that this HRSRM system is more efficient. I also wanna talk about some of the ideas we have for phase two. So –

Michael Deru: Go ahead, well continue how do we finish up phase one.

Grant: Oh yeah, so phase one is not quite complete. That's why these are preliminary results. One thing you'll notice is that we only have one RPM up there. What we would like to do is look at the other RPM ranges, so lower RPM's.

And so what we're predicting to – or what we're gonna be doing here in the next few weeks is we will actually go ahead and set the RPM, and let it run for anywhere from 30 minutes to an hour, so we can actually get a much more detailed power measurement and that's what we'll have.

So then we'll be able to have power versus multiple RPM ranges, and then moving onto phase two, this is where we can use those, the advantages that HRSRM is that is has an inverter for every motor, and then it also has a controller and this controller is going to – it can connect to the Internet if you want and it can do many more advanced processes than were previously available with your positional VSE.

The first thing we're working on doing is variable head pressure control and that is where you adjust your – compress your discharge pressure based on the outdoor air temperature, and that is a traditional system you can find.

We have some links and some references for that if anyone is interested but it basically just requires two different inputs to be able to input this onto any refrigeration system, any of these variable speed condenser vents.

The other problem with that is actually looking at doing individual motor control. One thing that typically happens is that you control your entire condenser fan bank all with just one VSC, and this loses some resolution. So one idea with the unique HRSRM that we're using is you can turn on or off individual motors.

And then finally, two other ideas. One thing is to actually adjust how you do variable head pressure control and make it a little bit more advanced so that it can take into account for example if you only have one compressor running.

It's not worth running all of your condenser fans. There's also many other factors that could affect into that. So creating some kind of different algorithm that would actually work better for variable head pressure control, that would save additional energy.

And then finally, the last idea for phase two was predictive control where we would actually give this controller the ability to predict what the system is gonna be doing and optimize for power and that's our last site. So if we have any – if there's any questions, please let us know.

Holly Carr: Grant or Michael, we have a question about whether or not there was any impact on the amount of air flow or cooling from the HRSRM versus the legacy systems.

Michael Deru: So we tried not to let that happen, right. We directly replaced the induction motor underneath with an SMC motor and these are providing the same power and torque. We also made sure that the RPM's are maintaining versus legacy and HRSM. So no, there should be no difference.

Holly Carr: Any other specific questions on these couple of projects? People can unmute themselves and just ask. All right, so I'll ask my question. Is there any way to – if we're seeing a 30 percent lower energy use from these motors, do you have an estimate of what that translates to in terms of saving for a supermarket refrigeration system that's employing these motors across the boards?

Michael Deru: So we haven't done that type of calculation yet but after we finish these other additional measurements and look at the – you know the power versus the different speeds, then we'd be able to make some kind of estimate there.

Holly Carr: Okay.

Grant: And I'd just add one comment to that is that we're just showing you the condenser power savings right there but phase two really can make any energy savings in our refrigeration system you want to affect how a compressor runs and make that more stable or more efficient.

Phase two is hopefully gonna actually start to work on the compressor power and that will safe hopefully a lot more energy.

Holly Carr: And what's the timeline for phase two?

Michael Deru: That is still to be determined. We're just trying to figure out exactly how that will be supported and when we would be able to conduct that.

Holly Carr: Okay.

Michael Deru: Those type of things.

Holly Carr: Okay, great. Thanks very much, folks and again, if you think of questions, you can type them into the interface. If we have time to come back to them at the end, we will but for the moment, let's go ahead and move to Daniel Wright at NASRC.

So Danielle is the Executive Director and will be talking to us about specifically about the energy efficiency place with natural and alternative refrigerants. Danielle?

Danielle Wright: Great, thanks, Holly. So as Holly mentioned, I'm Danielle Wright. I'm the Executive Director of the North American Sustainable Refrigeration Council, also known as NASRC and my background is really in energy efficiency and specifically in refrigeration, grocery and food retail sectors.

So today I'll be talking about the NASRC, what we're doing to support the transition to low GWP refrigerants or natural refrigerants, which is really our focus and how that ties back to energy savings for systems and technologies in the grocery and food retail sector. Next slide. Oh, so that's a little bit about me; next slide.

So who is NASRC? So we're a group of stakeholders in the grocery and food retail sector who have really come together to focus and overcome the barriers that have been slowing the progress of natural refrigerants and are the way that we're organized, you know we're basically trying to address three primary hurdles, and those are the hurdles of first cost and the hurdle of service readiness and contractor availability training, and the hurdle of codes and standards.

And the real core idea behind the organization is that coming together from different areas of the supermarket refrigeration industry, we can overcome these hurdles, that no one entity can really handle on their own or address on their own.

So towards that end, we've organized ourselves into progress groups that really are focused on taking direct actions to address each one of these hurdles.

So there's six groups currently that are listed here; so the return on investment group, the utilities and energy efficiency groups. We've got a group that's focused on contractors and service technicians, as practices, codes and standards and policy.

And some of the activities we're doing under these groups are working to improve the overall return on investment, really looking to help offset first costs with incentives, making sure that there is a workforce that's ready and trained to handle these new system types, developing case studies and best practices, addressing the gaps and some of the safety and engineering codes and standards, and tracking and addressing policy issues such as snap applications and other updates.

So really everything we do is driven by our members who participate in these progress groups, and next slide, a quick snapshot here of all of our members, really representing all the different types of stakeholders in the commercial refrigeration space.

So the majority of our members are actually end users. We also have service contractors, engineering, design and consulting firms, OEM's and product manufacturers, and utilities even, and other NGO's. Next slide, please.

So why are we focused on natural refrigerants or low GWP refrigerants in the first place? You know, our goal is not necessarily to make natural refrigerants the only choice out there but really based on some of the policies and regulations that have been driving these low GWP transitions, we believe it's really critical that natural refrigerants are first and foremost an economically sustainable choice.

So some of the regulations that have been really pushing the market towards low GWP refrigerants include the Montreal

Protocol, the Kigali Amendment specifically that will limit and the availability of the price of HSP's and have a little chart there that's showing the phase-down schedule but essentially starting in 2019 and over the course of the next few decades, we'll see an up to 90 percent reduction in that availability.

There's the EPA's significant new alternative policy or the SNAP program that limits refrigerants in specific end uses, and so we're seeing some of the common refrigerants that are becoming delisted and will not be available for use.

And then finally in California, the Air Resources Board is imposing some of the most stringent regulations that we've seen that are really targeted towards achieving their greenhouse gas reduction goals by reducing HSC emissions.

So we're seeing a prohibition on refrigerants greater than 150 and new equipment starting in 2021, and this is just what's been proposed. This is not something gone into effect. This is the rule-making that's going on now.

And then a restriction on the sale of refrigerants, first greater than 2,500 GWP and then greater than 1,500. So we're really seeing a need to address the transition towards low GWP refrigerants and again, you know, do so in a way that's most economically feasible for grocers.

We are seeing an adoption increase on a global level, next slide. You know, terms of just looking at CO2 for example, transcritical CO2 systems, we're seeing high rates of adoption, particularly in Europe. The EU is currently implementing a more ambitious HSC reduction measure than even California is proposing and we're also seeing that many retailers in the U.S. have begun to adopt low GWP refrigeration systems, and really the low GWP technologies are growing quickly across all climate zones, including those with the high ambient temperature. Next slide.

So how do these systems compare in terms of cost and performance to a traditional HSC based DX system? Today, I'm gonna focus on four that have really the lowest GWP and it's worth noting that none of these are drop-in replacements and really require a replacement of the entire system.

So this table just compares the risk factors to a traditional DX system. You'll notice that three of these systems have a higher initial capital cost and this is really driven by the lack of economies of scale. NASRC has done some analysis on the various components and parts, and really determined that it's not a factor of having to pay a higher import tax or low competition but really just that the demand is not there to drive the economies of scale that can allow that lower price.

Just like any new technology, for example LED refrigerated case lamps, you know, the cost isn't high initially when adoption is low but will be driven down as volume increases, and that's definitely one of the areas that we want to focus on is how to really accelerate that development.

So the first system here, ammonia, CO2 cascade systems, there's really only four of these in the U.S. and the higher capital costs here are really driven by the fact that the majority of these applications have been in the industrial sector and that the equipment manufacturers were really geared towards these larger, more expensive systems that are over-sized for supermarket applications.

So manufacturers are starting to look into making equipment sized for commercial applications. Some of those are members of ours, and heavily involved in the NASRC but it will take some time to get this new equipment to reach economies of scale and drop that initial high price, but overall, good energy performance when it comes to the system types.

For the propane over CO2, there's really only one installation and technically there can only be one until this is approved as an end use by SNAP. NASRC is working on that application now and we were – some of our members were hopeful in getting that test pilots or test – testing permission from SNAP to move forward on that project.

The jury is really out on the energy performance. The site is relatively new. For CO2 trends, critical that you know, the last count almost a year ago was over 250 sites in the U.S. I wouldn't be surprised if that's doubled by now and really we're seeing mixed results when it comes to the energy performance of the system. Next slide.

So overall historically, there's been good performance in the areas where there's a colder ambient temperature with you know, savings that we've seen and documented up to 20 percent savings over a traditional DX system, a baseline system.

But then on the other hand, there's some – and I know that some of the – the last call referenced this number that there's – there can be energy penalties in longer ambient climates, up to a 20 percent over that baseline.

So really depends on the location and Tony mentioned how that system is designed. So there have been a number of advances and new technologies that can significantly improve the performance of that system.

Parallel compression injectors, and you've got gas coolers and really there's systems that are being installed today with – that include all three of these technologies in Southern states like Georgia that will really help tell us more about the performance of the CO2 transcritical system once the monitoring period is complete on those installations.

Overall, the transitions to these low GWT systems requires a very large capital investment. As I said, it's not drop-in ready. You have to replace the entire system. So one alternative option that's emerging as we go to the next slide is what we call self-contained systems.

This is also being called a microdistributed system. It's pretty new. So there's not really an agreed-upon industry name but essentially it's a store filled with self-contained units on a one to one system.

Each unit has its own evaporator with a compressor and condenser, and the heat can be rejected either through the air-cooled condenser on the unit or can be removed through a water loop that can also be used to keep the store in cooler climates.

Some of the benefits of the system types include that has a very low charge. You have a little table there comparing it to our 4A system. You know, a virtually no-leak rate and another benefit is that there is a flexibility in merchandising.

These can really be plug and play, moved around the store, depending on the promotions that are going on that week. There's also a flexibility of converting the store if this is a retrofit.

All the other system examples I spoke about, you really have to go in, replace everything at once. This could be an option where a grocer could choose to replace one case line-up at a time, you know and really not have to go through the disruption of closing down the entire store.

There's also lower cost of installation, so reduced cost of engineering, really that store and it's simple to install and maintain these units.

The energy performance has been really good. We're seeing savings between 30 to 50 percent over the baseline depending on the unit type but the one major barrier here is that there is a current charge limit of our two nice indy which is 150 grand, which is about the same as a typical cigarette lighter or bic lighter.

And really this is not enough charge to provide the cooling capacity that's needed for something like a fence or you know, 12-foot open multi-deck case. You'd really need to install two circuits into a case like that and that's cost prohibitive to do.

So this is one area where NASRC has decided to take direct actions. As we go to the next slide, we actually held a workshop on Tuesday this week in Washington, D.C.

The goal is really to bring together the different standard bodies. The UL ashtray, the APA SNAP team to agree on an action plan for safely raising the charge limit in self-contained cases.

We had a good example to go on the IAC global standard as moving to 500 grams. So our goal is really to harmonize with the standard and do so in the most expedited way possible, which is hard to do if you have any experience working with codes and standards.

Things move slowly, so one of the other things we're doing is circulating a petition that calls for the expedited review and revisionist building codes, so that we can really keep up with the speed of today's – of all these technologies.

We'll have a space on our progress here. So we'll have a webinar as well as an in-person event where we'll actually tour an existing store that's been converted to all self-contained cases and if you'd like to get more information on that you can sign up for our newsletter. Next slide.

The final thing I wanna talk about today, so going back to the concept that the overall transition to low GWP systems is so incredibly expensive, represents a large capital investment.

One really big area of focus for us is to develop funding mechanisms for both the energy efficiency and greenhouse gas emission reduction benefits. So there are several options right now for energy efficiency incentives.

Technically, you can pursue utility incentives but there are complexities there that I'll get to on the next slide. California's EPIC program, the Electric Program Investment Charge. Which was established by the CPUC to support investment in clean energy technology.

This program makes $120 million available on an annual basis and as of this year because of the work that NASRC has done now includes projects and programs that can accelerate low GWP refrigerant technologies and systems.

The —there is a small utility, SMUD, the Sacramento Municipal Utility District that has a pilot program going on right now called the Natural Refrigerant Incentive Pilot which offers both incentives for energy efficiency and the greenhouse gas emission reductions.

On the greenhouse gas emission reduction side there is state and national supplemental environmental projects which can fund environmentally beneficial projects using settlements for environmental violations.

This is something where you need to submit an application and something that NASRC can help with. Also, you know, there was some funding allowed under California's budget in 2016; $20 million towards funding low GWP refrigerant projects.

Unfortunately, that was cut from the budget. One of the items or the feedback we got is that there just wasn't enough support for the budget items. So when we were hoping to change that in the future, we've established an incentive task force and to try and voice some of those opinions on really supporting this type of incentive funding in the future. Next slide, please.

And I realize we're running low on time, so I'm gonna kinda go through this pretty quickly. You know, essentially one other area we're focused in is specifically working with utilities to look at several ways to take advantage of the potential for energy savings that we're seeing here.

So one of those approaches is through the development of a custom tool that's broadly accepted by utilities to help predict and validate the savings for low GWT systems.

We held a workshop on this back in September of last year and we're currently working with two of the California IOU's, PGE and SCE to help kick-start a feasibility study that should be out later this year, and then in other areas that we're working actively with our members to develop several deemed or prescriptive measures that utilities could adopt.

We have here the list of nine kind of prioritized measures and we're organizing subgroups to work together to get the information that utilities need to move forward on these.

So my last slide is just really about what you can do. You can get involved. So there's a number of ways to do that. You can join one of our progress groups, so it's working on some of the activities I mentioned.

You can join our task forces on the codes update on the incentives for low GWP systems, and most importantly sign up for our newsletter, so that you'll get the latest and greatest information and that's it.

Holly Carr: Thanks.

Danielle Wright: Sorry, that was the next slide.

Holly Carr: Thank you, so much Danielle.

Danielle Wright: Right, yeah.

Holly Carr: Can you go to the next slide, Vicki, so we can – folks can look.

Danielle Wright: Okay, there we go, excellent.

Holly Carr: So I know it's 5:00 o'clock, 5:01. I certainly understand if folks need to jump off but I do wanna open it up for folks who might have questions. Please feel free to unmute yourself and just speak. Otherwise, we had a couple of questions come in through the interface.

Folks are interested in the specific proposed design and citings for CO2 installation. So CO2 system installations, I think even Tony mentioned that they've seen energy savings from systems that are properly designed and properly cited.

So that is something we've already talked with NASRC about and also with Tony about is either gathering resources that already exist in making them available to Better Buildings Alliance Partners or perhaps develop a brief resource of tips and tricks for designing and siting CO2 systems, so that you are in the best place possible for seeing energy savings, rather than energy increases.

Another question and Danielle, let's just continue to connect on that resource or set of resources. We also had a question for Michael and Grant regarding the HRSRM loader, wondering if it can run at 11480 RPM. Michael or Grant, do you know that information?

Grant: Yeah, this is Grant. I believe they can go up to 3,000 RPM. So they should be able to do 1,000.

Michael Deru: Yeah, they can operate at any RPM between 150 and 3,200 or 3,600 RPM's.

Holly Carr: Great, Thanks, folks. I am hoping that this will be the first of a couple of refrigeration conversations that we'll have related to this priority for retail food service and grocery, and certainly open to anyone else in the alliance who is interested to participate.

Obviously, our hospitality and healthcare partners also have a lot of refrigeration going on. So thank you very much for joining this call. Let us know if there's specific topics that you'd like to cover in a future conversation, and we're certainly hoping to have a refrigeration session at our next summit, which will be this summer. So thanks again, folks for joining and we'll talk to you again, soon.

[End of Audio]