Hannah Kramer: Hello, everyone. Welcome to the Better Buildings webinar, EMIS for Small Buildings with UC Davis. I'm gonna wait a couple of minutes as folks join, and we'll get started soon.

All right, well, we'll get going with bios. I know a lot of people joined in the first five minutes. I'm Hannah Kramer with Lawrence Berkeley National Laboratory, and I'm pleased to be joined today with our speakers from UC Davis facilities energy and engineering. They run a very large campus, the whole campus at UC Davis, and have a lot of experience that we're gonna gain from in this webinar.

So, I'm gonna give a quick bio introduction, and then we'll just turn it over to them. We'll have time for Q&A at the end, so please get your questions in through the chat function.

So, first of all, Nico Fauchier-Magnan has 15 years of experience in the energy efficiency industry. He started his career in energy efficiency consulting in California, then worked for a mechanical engineering firm in Switzerland, and is now managing a team of five people at UC Davis.

His team develops and implements energy efficiency projects on campus, and their funding is entirely based on the verified energy savings they generate, which is a very unique model, I think, for a campus. So, the success of each project impacts what they can do for the next project, and they have to do M&V to to prove their savings. So, that'll be something that if you have questions on that, you can ask about that in this presentation.

Next, Josh Morejohn serves as a director of energy and engineering for facilities at Davis, and his team leads innovative energy initiatives across campus, manages the campus control systems, and develops energy-related Web apps for campus engagement and education.

I'll just put in a plug there – they do really cool stuff with developing ways to get data from occupants, and we should probably put that in the chat at some point. Really interesting stuff there. He's a licensed professional engineer and certified energy manager, and double-majored at UC Davis in mechanical engineering and Spanish.

Next, we have Tom Ryan, came to the energy conservation office in 2018 as an energy project manager, and he uses his 15 years of construction experience to help his team realize energy savings around campus. He's a PE in civil engineering and a master's degree in environmental engineering from UC Davis. He led the UC Davis student teams in the Department of Energy solar decathlon competitions in 2015 and 2017. He loves to get things done and save energy on campus.

And last but not least is Nathan Cardoza. He has been working for UC Davis for 16 years and leads their refrigeration team in the mechanical HVAC department, overseeing 11 refrigeration technicians who maintain all the refrigeration equipment on campus and all the air conditioning equipment that's not connected to the campus chilled water loop. This includes thousands of pieces of equipment across campus, so they have a lot on their hands.

And really, that's what this position is all about – how you get to those pieces of equipment that are not on your building automation system, and they're gonna give the nitty-gritty details of how they've done that at UC Davis. Next slide, please.

So, I wanna start off by putting this topic in context. There's lots of small buildings, obviously, that use package units and programmable thermostats, and traditionally the EMIS group – Energy Management Information Systems at LBNL has not focused on these systems so much, but instead focused on large, built-up HVAC with building automation systems.

However, we're gonna be having a new, expanded focus next year on small building controls and analytics, so today we'll have this group of experts from UC Davis kick us off on this topic. One of the things I really like about what they have to talk about today is their real-world experience at implementing these kind of networked thermostats with rooftop unit controls on 120 buildings across our campus.

So, these buildings – they'll talk about this – that they previously had various levels of control, no way to monitor remotely, and now they have a real solution for that problem. So, let's jump right into their approach, which is called SWARM – small workplace automation and remote monitoring.

Again, a reminder just to please type your questions into the chat box at any time. I'll be moderating those questions and asking them at the end. Slides will be emailed after the webinar, along with the recording. Thanks.

Nico Fauchier-Magnan: Great, thanks everyone. Let me jump in and thanks everyone. Thanks for a great intro, Hannah, that was perfect. So, I'm gonna give you a bit of an overview of what SWARM is, how we came across – or how we started developing that product for our campus.

But first, before we talk about the school buildings, like Hannah said, we kinda had the same approach for a while of focusing on our large buildings on campus, or the labs and big classroom buildings that are connected to our chill water or steam loops, have great building automation systems already in place for complex VAV and built up units, et cetera.

But we also have a lot of small buildings on our campus, 20,000 square feet and below that, and they make up about 15 percent of our total square footage, so it's not negligible at all. For a while, we didn't really have a good solution for managing those buildings, managing the HVAC units in those buildings.

So, these standalone HVAC systems, not only were they not connected to a chill water plant, they were also controlled by standalone thermostats. So, one of the main issues with that is that it makes for a not very pleasant experience for the customers or for the occupants of the building.

First of all, these thermostats are not user-friendly at all. You can see how much instruction it takes here to explain to people how to do an override on your set thermostat. It really should be simpler than this. Sometimes you have two thermostats side-by-side and not really sure which one does what.

And you can see, you know, it's just really not user-friendly. And people are also really uncomfortable, because either the unit didn't come on and nobody knows, or people don't really know how to activate the thermostat. And so, sometimes people get creative and this is a real-world solution that we've seen in a building – people just putting a box fan on top of their diffusers to get more airflow in one zone.

So, that's kind of a big issue for us, because that's a lot of people that are uncomfortable and aren't at their peak productivity, I guess. So, that was one reason we wanted to change things.

The other reason is from a maintenance perspective, our maintenance team who's taking care of all these units had no visibility into the HVAC system. So, anytime there was a comfort call or equipment issue, the only solution for solving that was to send a technician out there in their truck and spend time on-site, diagnosing the issue. That's just not very time-effective. It makes for a longer response time as well, and it just isn't really good in the long run.

And then lastly, and last but not at least from an energy perspective, we also had, at best, "programmable thermostats" that weren't programmed for correctly or we also had non-programmable thermostats. So, a lot of the systems were running when the building was unoccupied.

So, we really had the worst of all worlds. We have buildings that aren't comfortable when they're occupied and are wasting energy when no one's there, and we can't really maintain them very well. So, really a bad situation in all those small buildings. For a while, there wasn't a really good solution until a few years ago. So, we were really happy when we found a product that worked for us. So, this is what we did.

We found – well, we looked at several vendors and we selected one to have Web-enabled thermostats in all the small buildings. We started this as an energy project, so we wanted to improve scheduling of the HVAC in all those buildings, but we also knew that there would be lots of benefits for the occupants, and so we could set schedules that would match when people were in the building so that the buildings would be comfortable when somebody shows up in the morning, and would stay comfortable for the day.

Then Nathan's team, our maintenance team, quickly got on board with the system as well, because they really saw the benefits of that remote troubleshooting ability, and he'll talk more about that. So, that's really the three main goals and benefits we're getting from the system here – comfort, maintenance, energy use.

One extra point that's worth mentioning on the maintenance side is that the system also gives us confidence in our economizers, so some package units, oftentimes they will have an economizer, and oftentimes those aren't really trusted by maintenance team for good reasons, and so they're often disabled because they will stay stuck in full outside air mode, and so when it's 100 degrees outside, the unit can't keep up, or they just cause issues in a traditional system.

With this system, we're able to see those issues and address them before they become problematic for the building, so we can have confidence that we can have economizers that work on those small package units. So, that's a big deal for maintenance and for energy as well, obviously.

So, this is the overall result so far. We've scaled up our system pretty well. We have about 120 buildings in our platform, controlling over 2,000 tons of heating and 2,000 tons of cooling. We're saving close to a gigawatt hour every year, and that's resulting in about $70,000.00 in savings at our very low energy rates.

So, if you're – if we had some more typical commercial rates, it would probably be more in the order of 150k per year. And we invested about 200k overall to get control in these 120 buildings, so in relative terms, this is a really cost-effective investment here.

This number, our maintenance team really likes to see that, that we're decreasing the run time of our compressors and our heating systems, so that means extended life, less wear and tear on the equipment, so great for them as well. I'm going to pass it on to Tom.

Tom Ryan: Hi, everyone. I'm gonna just be speaking briefly about how our SWARM system works. Next slide. We'll just dive right into it. So, in the very beginning of this project, which I was not involved in, there was a big choice to make, and that was which technology to go with.

We ended up going with the first one here, but there are a number of technologies out there, and they may be – one might be beneficial to a certain site over another for a variety of reasons, depending on what your criteria area.

Four years ago, three, four years ago, when this decision was made for our campus, the industry was a certain way. Now it is much different. For example, the ecobee was pretty focused on residential at that time, and it looks like they've actually started going more into the institutional and commercial realm.

So, I think a lot of these companies are taking the hint that this is a market to be tapped into. I think our decision-making process would be a little different now if we had to start this project over.

So, the first thing to do is decide what's important to your site if you are interested in doing this for whatever site you're at, and create a matrix of criteria, and make your decision based on the research they have to do, and if you need any help with that, we'd be happy to. Next slide, please.

So, this is a picture of some of the equipment that we have on campus, and this is kind of a basic, one-line setup of what we have. Now, we have – IT requirements on our campus are pretty strict, so that was one of our main reasons we went with the technology we did.

But these units are spread out, the zones are spread out. We can't do a lot of wiring in between those, so we wanted to keep it cost-effective. So – but we also needed to have a wired connection to the Internet. So, we have a gateway here, as you can see, that's wired to the Internet on its own separate VLAN. It's not exactly – it's not wifi, but it creates a mesh in between all of the pieces of equipment that we have in the system, which is kinda great.

So, we get the signal from the Internet via the gateway, which is secure. It actually transmits from the thermostats to the gateway, there's a one-way communication here, which is another IT requirement. I'll go into that a little bit. But the thermostats actually are able to jump the signal from thermostat to thermostat, and also we have repeaters which look very similar to the gateway you see here to basically create this mesh network that you can expand and expand and expand, as long as you can get a signal.

Sometimes we're far enough away we have to put in another gateway or we put in another repeater to extend the network, but it is a closed network, and everything kind of communicates with each other. Next slide.

I should also say on that last slide, I didn't really mention it, but the economizer controls our – yeah, sorry about that. So, there are thermostats, they're standard temperature thermostats, which is their basic. They also have ones that are able to sense CO_2 and humidity.

We don't use a lot of the humidity control, but we could. You can see in here it has a standardized control for the economizer as well, and that's one of the things that actually makes the economizer effective, is that it's standardized and it's simple, and it's one system.

It isn't – a lot of the problem is Carrier has a certain control and control schematic and way of controlling the economizers, and then there's Honeywell has one, and all of these different companies have different ways of controlling, which makes it a little bit more complicated for a technician to figure out as well. Next slide.

Okay. So, this is kind of the back end, so to speak. This is what the users would see, and by users, I mean us, the admin or the technician. This particular system is designed to be seen pretty much from your phone, so any smartphone will have the correct aspect ratio. If you see it on a desktop, it's kind of the same thing.

The cool part is you can – this is how you interact with the thermostat itself. You can change the temperature locally at the thermostat, but to get into the scheduling, to get into the equipment or any part of it, including locking the thermostat itself, if you have people who have differing opinions about what temperature the office should be, for example, this is where the technician or an administrator would change all the settings.

Also, there's an event calendar. You can do regular scheduling or 4th of July, holiday shutdowns, which we do on campus as well. On the technician side or the maintenance side, we also have history graphs that are connected to each thermostat, and as you can see in the graphic here, you can see when things happen, so the technicians are able to diagnose issues remotely. Nate's gonna go into that in a little bit, so I won't really get into that. Next slide.

So, I'm not gonna go into our specific IT requirements so much, but suffice to say this was a bottleneck in our selection process and something that we really had to make sure that our IT department was satisfied with before we could proceed with any company.

So, these are just some of the criteria that we had to make sure was possible with Pelican Wireless, which is the company we went with. But at any individual site, it's gonna be a little different. Your security requirements are going to be different, and that is probably going to be the most important part.

So, do not negate this part of the selection process, because it can stop you in your tracks. Okay. And I'm gonna hand it back over to Nico. Thanks.

Nico Fauchier-Magnan: Great, and we're gonna talk a little bit now about – yeah, we're gonna zoom in a little bit on a building that did get the SWARM thermostat and get included in the system, just to see – put a little bit more real life to it.

So, these are first kind of typical types of building that we included in SWARM. Smaller buildings or annexes, temporary buildings, trailers, isolated labs, or even sometimes a room within a larger building that has a standalone package unit. Our athletic facility – you can see our stadium here. All those locker rooms, fan boxes, et cetera, those are all served by little package units on the roof, so those were great candidates for SWARM as well.

Total area that's in the SWARM system right now is about 440,000 square feet, and those buildings range anywhere from 650 square feet for the smallest to 28,000 square feet. So, that gives you a sense also of what is a good target here.

So, let's dive into one specific building. This one is a little bit on the higher end of our typical buildings here, 20,000 square feet. You can see it's basically five or six double-wide trailers put together, and they all have fairly large package units on the roof heat pump units.

One good thing about this building is it had an electric meter before we did SWARM. That's not always the case with those smaller buildings on our campus. And there were economizers on all the units as well, already in place.

So, just to give you a sense of the energy reduction we saw from putting SWARM in place at this building, so in dark green here, you can see the energy use in 2017 before SWARM, and light green you can see what it was after SWARM, here. So, this is monthly totals.

If we dive into the daily totals here, each little dot here is one day's worth of electricity consumption. You can see same color scheme – in dark green, we're quite a bit higher almost all the time than after the fact. So, in a regular day, we get benefits from improved scheduling, improved set points, maybe better economizer control as well.

And obviously on weekends and holidays we save a lot of energy there, because we just don't run the systems when no one's in the building. Before SWARM was in place, the schedule would keep units on during the weekends.

So in total, at that building, we've seen about 120,000 square – I'm sorry, 127 kWh annual savings, which comes out to about 7k per year, and that's – the whole building, that's about a 40 percent reduction in energy use intensity. So, very significant here.

So, that's for the energy side of things. I'm going to share with you guys a little video that Nate made to kind of illustrate the maintenance benefits as well. So, let's see – there you go.

Nathan Cardoza: All right, guys. One of the quick ways that the service guys use the Pelican to help them troubleshoot is by looking at a specific thermostat when it goes into alarm. So, for instance, we're gonna go into the s zone, 178A, which is a certain building, and we're gonna start looking into a specific thermostat.

Okay. When you go to history graph, an obvious bonus is being able to look at historical data in a lot of detail. But on this specific day, which is November 1, we had a temperature failure right here, starting to nosedive on a call for heat. So, we know that there was no ignition that took place because the supply temp, which is down here, and the space temp were both going in a downward trend.

So, I noticed that when we got the alarm in the morning, because the alarm is configurable but we have it set for a 5 degree deviation, anything 5 degrees or more will cause an alarm. So, then we did get that alarm the next morning at 1:56. We could have got it sooner if we wanted to keep a tighter alarm set point.

However, that being said, I did – I was able to look at it at 4:36 that morning and what you can do in Pelican in order to reset the ignition module, which locks out on occasion, you can turn the command off for heat, and then turn it back on, and that resets power to the ignition module and allows your unit to come back on in heating mode, if it could reestablish flame.

So, that's what happened here, and that bought us some time so I could send a technician out to investigate why that ignition module locked out. So, the ignition module locked out because there was a bad gas valve, and the bad gas valve was intermittently going bad, so the technician found it and replaced it.

But it was very easily identified that the ignition module locked out, because when I recycled power and it fired back up, the only thing on this specific unit that could do that is the ignition module being locked out. So again, this is a great tool to use to not only buy you some time by potentially resetting the ignition module, but also getting the alarm sent to you and then having the historical data to know exactly when it failed.

So again, the ability to just hone in on the exact specifics of what was going on through here is huge. We always like to add supply sensors too, so at a quick glance we can do some verification of the unit's operation. All right, thanks.

Nico Fauchier-Magnan: All right, I'm gonna do now a demo of more of the energy side of – or the energy benefits of this system. So, this is kind of our campus divided into different zones, and I'm going to take you to the childcare center on campus and show you one of the first features and how easy it is to set up a schedule for a building. So, let's go back here.

Just real quick, before we even get into the Monday-Friday, what we're doing for this particular thermostat was we just set one schedule for the whole building, so this is the whole childcare center as a general schedule, and we just told this thermostat to follow that schedule.

We can go look and see what that means, we can see that it's set to be in a comfortable range by 7:00 a.m. And here, you can see this optimum start function, which means that the system kinda learns how long it takes for the building to heat up and it saves you from having to set a 5:30 a.m. start time just to get to the right temperature by 7:00 a.m.

The building just knows – or the system just knows how long it takes to heat up. So, that's a really nice feature. Then you can see at 6:00 p.m. we start relaxing the set points a little bit, and then at 8:00 p.m. we turn everything off.

You can even define if you wanna lock the front keypad or not at different times of day, and here, you can see in the afternoon it's unlocked, probably to let the teachers manipulate the set point in their classroom a little bit when it gets hot in the afternoon.

You can also look at those schedules in a more high-level view, so on the schedule dashboard here, you can look at them more as a calendar and see all your building schedules and then individual thermostats, and what time they start and stop, et cetera. So, that's also really nice, a nice way to do this.

The second nice feature that we like from this system is the ability to give some control to the occupants over the temperatures if the space is – makes sense for that. We don't typically do that in a shared classroom situation or a shared space, but for a regular office situation, we can go into the thermostat configuration and adjust the set point here that we can let the people adjust the heat up to 72; adjust the cooling down to 70, and we can change this on the fly here if we want.

So, that's also a nice way to give some control to the occupants within certain boundaries. The third thing I wanted to show you is the economizers that we've talked about a little bit, and for that I'm going to take you to our telecom building.

When we installed SWARM at this telecom building, it basically has a lot of IT load in the building. You can see this unit is running its compressor. It doesn't have an economizer right now. But when we did put SWARM in place, we decided to add some economizers to the units.

I'm just gonna show you what that did to our compressor runtime. So, this is what happened. Yesterday, you can see we maintained our space temperature really well, right around 72, right around the set point. We did that only with the economizer.

So, the whole day, the economizer was open. You can see that right away on this graph. You can also see here our supply temperature was really stable throughout the day. So, that's how we just kept the set point really well. You can see as the outside temperature changed throughout the day, the economizer responded by opening and closing its – modulating its sampler I guess. So, another really nice feature.

Okay. The last one I'm gonna show everyone here is the ability to do demand response, and to enroll into a demand response program really easily. So, here you can pick which program you want your thermostats to receive events from, and the pre-populated ones are based on your ZIP code.

So, the local operator for us is SMUD, so those are the two that we have here, and then we also worked with the vendor to have our own ability to do demand response for our campus. So, once you've set that up, there's a few more parameters here.

The one important one is here's one – there's a high event, which is a demand response event. You can define how many degrees you want to increase a set point in the thermostat. So, we've selected to raise the set point by three degrees when there is a demand response event.

Then you can – the second step is to just select which thermostats you want to respond to an event. You don't necessarily want all your buildings to be affected by a demand response event.

So if we go back to this telecom building here that we were looking at earlier, obviously that's an IT load we don't necessarily want. The set points are changed in there, so that one is excluded, but everything else here is included.

So, that's it for my demo here. We'll take questions at the end, but before we jump into the Q&A, I just wanted to give you a few pointers or ideas, in case you're thinking about getting SWARM started for your portfolio or your campus, your school, district, whatever it may be. A few pointers for how to approach that.

So, the first one is to identify – I think kind of the first step is to identify which buildings would be good candidates for this type of approach. So, what we've seen is smaller buildings, basically under 20,000 square feet, roughly.

Those buildings are typically where a connection to a traditional building automation system is not gonna be cost-effective, because there's not enough complexity or not enough energy use in the building to really justify the high cost of a traditional, more complex building automation system.

Then once you've assembled a large list of buildings, you can refine it and just select a few buildings to do a pilot, and it's a good idea to pick buildings that have energy meters on them, electricity and gas, so that you can do before-and-after comparison. Not a requirement, but it's nice to have.

It's good also if they have the ability to be scheduled, and strangely enough, maybe this one may surprise you, but if there are occupant complaints about comfort in the building, that also tells you that the systems aren't running very well. So, it's an opportunity to showcase that SWARM can help improve comfort as well.

Then you have to select a vendor, obviously. As Tom showed, there is lots of options. These are key considerations that you want to keep in mind when you're selecting a vendor. These first two are really related to IT, and the reason we really highlight that is you're basically connecting devices to the Internet, and those devices are going to be great targets for cyberattacks of all kinds.

So, your IT department is gonna know that, and they're gonna be scrutinizing the technology you select very closely. So first, before you look at any vendors or talk to vendors, I would say talk to your IT team and figure out what are their requirements for security, and we can share also what our IT team asked us to do for that.

Then just find which type of communications will work best for you. If you're able to jump on the wifi, that's great. That's not an option for our campus, but depends on the site, obviously. You wanna look at the type of interface you have, how scalable it looks, the ability to set up schedules, alarms, to look at trend data, et cetera.

Then you also wanna think about okay, what kind of HVAC do you have in your portfolio? We have mostly rooftop units, but if you also have fan-coils, a VRF system, et cetera, those are good criteria to keep in mind when you're selecting your vendor.

It's always good to have the ability to give control to the occupants, within certain parameters, obviously, as we've seen.

Then last but not least, ask yourself or ask the vendor what they provide from a maintenance perspective in terms of alarms, notifications that are pushed to either text or email, and how easy it is to set up the system eventually.

So, yeah, just again, highlighting who you need to get buy-in from. So, being a little repetitive here on the IT side of things, but yeah, if you take one thing away, that should be the one here.

So, just see what your IT team wants and once you've selected the vendor, come back to them, your IT team, and discuss, make sure that vendor matches or meets the requirements. Then you also want to get buy-in from your maintenance team, make sure that they like the system, that they'll be using it.

Because that's a huge benefit of SWARM, so make sure they're on board with that. All right, that's it. Gonna hand it back over to Hannah for questions.

Hannah Kramer: Thank you, Nico. That was excellent, and we have a lot of questions that have been coming through. I want you all to click the Q&A button, because Josh has been great about providing written answers to some really excellent questions. So, I'm gonna ask some questions to the UC Davis folks but there's also a number of ones that are written in the Q&A.

In our follow-up, we'll also provide those Q&A, the written Q&A in that follow-up, so you have documentation of those answers. Thanks for doing that, Josh.

So, I'm gonna start off with kind of a board question. You've talked about it somewhat, but how much time does your operations team save by having a view into the data, and was your maintenance team on board from the beginning, or did it take time to see those benefits?

Joshua Morejohn: I think that's a good one for Nate to answer.

Nathan Cardoza: Yeah, hi, this is Nathan. As far as from on board from the beginning, I would say 100 percent. We attended local vendor training, which taught us about the technology. I think initially, there's always a learning curve, and the sooner you understand the product, the more you buy into it.

So, from my perspective as a supervisor, it was my job to kind of motivate the employees and show them the benefits. The energy side, obviously, from a service technician, isn't as focused. They wanna know how it can simplify their life.

Once I showed them that, then the maintenance crew was on board. It's been so – it's been accepted so much that we're even going into pieces of equipment that don't necessarily save energy; they run 24/7 for, like, animal rooms and things like that. We've expanded this technology into that equipment as well, so the buy-in has been drastically successful.

Hannah Kramer: So, can you talk about just an example of your operations team saving time by having this data available? I think that'll really drive it home.

Nathan Cardoza: Well, I think saving time, there's a lot of factors. In fact, right after this meeting, I'm gonna meet a customer on a new building that has concerns about temperature deviation within a building.

Traditionally, we would have to go set up data loggers throughout the building to gather the metrics needed to verify their concerns, because as you know, everybody has different levels of comfort.

So, it's all about gathering metrics throughout the building to verify what they're reporting to us. Historically, we used to use temperature loggers and then we'd have to go back and download them, and it was just kind of a long process.

What I'm gonna do today is take a thermostat, a Pelican thermostat that's battery-operated, so I could place it anywhere in the building that they're considering an area of concern, and I will launch the thermostat and then I'll be able to see the temperatures remotely and monitor them.

And they'll be able to see them as well, because I'll be able to invite them to that thermostat. So, it's just a more effective and time-efficient way to troubleshoot in that method as well.

Hannah Kramer: Mm-hmm. Great example, thanks so much. Next question actually was written in the Q&A, but I want someone on the UC Davis team to expand on it a little bit. How do you decide whether to bring a small building onto your BAS network versus the SWARM network? Who wants to take that one?

Nico Fauchier-Magnan: I can take that one, or I could take a first pass at it. I think one criteria is the complexity of the systems in the building. So, any time we have a built-up unit with multiple zones or a variable air volume type of system, that will probably be too complex for a SWARM approach. So, that would be a better candidate for a central BAS.

But when we have simpler, single-zone systems, or even in some cases – Nate can – is more of an expert on the multi-zone capability of SWARM – but yeah, simpler systems where it wouldn't be cost-effective to bring in our big, traditional BAS, then that's how we would go with SWARM.

So, something that's not connected to central water loops, not connected to the steam loop, has package units on the roof or wall-mounted. Sometimes, those can be animal buildings or small labs that are off-campus that just have single zoning units. They're not necessarily insignificant buildings, but I think that's one of the criteria, is what type of equipment is present in the buildings.

Hannah Kramer: Mm-hmm. Great.

Nico Fauchier-Magnan: Nate, you wanna talk a bit about what you've done for more complex units?

Nathan Cardoza: Yeah, so we're utilizing Pelican kind of above and beyond the comfort level that it was originally presented to us. Once we found the technology was out there, we continued to challenge ourselves in expanding on some of the basics.

The basics would be comfort cooling, a traditional thermostat. A lot of our equipment on campus is running 24/7/365, so Pelican does allow you to control, modulating either digital scrolls, a signal, or modulating gas valves in order to maintain a specific temperature to reduce the cycling on and off of heating or cooling, to where you get a more even supply temperature.

So, I think the complexity in which you can use the technology is allowing us to expand into a lot of different areas that we didn't originally anticipate. So, I've talked a lot with the engineers over at Pelican and really pushed them to elaborate a little bit into some of our specific pieces of equipment, and they've enjoyed it, and we've enjoyed it as well.

Hannah Kramer: Thanks. What about – the question on this one is is the system able to detect the faults, or is it just the trend data that you can see to analyze it yourself?

Nathan Cardoza: I guess I could take this one from a technician level. So, in that video, I showed the example of a five-degree deviation in winter, meaning the space temperature set point in heating was – I think it was 72 at that moment. So, there's alarm parameters within Pelican to where you could tell that okay, if it's two, three, or four degrees, whatever you choose, whenever it deviates from that set point it will send you an email.

All that is customizable. You could have it email whoever you insert into that slot. So, there's perfect – like if the stat goes offline, meaning that if the stat loses communication from the cloud, it'll notify you. And if the stat deviates from set point to a degree in which you set, it will also notify you.

Hannah Kramer: Great. Here's a question about standardization across the portfolio. Would you all say that an organization would wanna select only one vendor to do this kind of approach? And does it make it difficult to switch vendors later? Do you need to standardize on Pelican hardware for your solution? Pelican or another single hardware ecosystem.

Nico Fauchier-Magnan: Right. Yeah, I can take that one. I think initially, when you're selecting a vendor, it's probably a good idea to test a few different technologies at a few single buildings and get a real sense for how they compare in real life. Not just relying on sales pitches, et cetera.

But once you're deciding to scale up to your whole portfolio, I think picking one vendor and sticking through it is really important. And a couple of reasons for that. One is most of these vendors also – they don't just provide the hardware, they also provide a platform, kind of similar to what we saw for Pelican. They often have something like that.

So, if you have different vendors, that's gonna mean different platforms, and it may not be the best or the easiest thing to maintain in the long run. The second reason is it just makes it simpler. Your technicians have one system to learn instead of several. Everything is in one place. I think it's just easier overall.

So, I think it's important to pick the right vendor, but then yeah, standardize on it, and it would – switching vendors would require taking out the hardware you've put in and putting in new hardware. So, I think that would be more difficult.

Some of these, if you wanna get into the details, some of these vendors are backnet compatible, et cetera., so you can do integration that way. But that just makes it more complex. It's nice to be able to just plug in a thermostat and it populates into this interface right away, there's very little setup to be done.

Hannah Kramer: We had kind of a follow-up question on that – how long does a typical setup take for, let's say, a single thermostat?

Nico Fauchier-Magnan: I think that's a good one for Nate.

Nathan Cardoza: Okay. So, when you set up a system, it's kind of multi-layered. We always start with the gateway installation and then broadcasting the communication into the building to when we put a thermostat on the wall, we could program it through the cloud.

So, that is a first step process that, depending on your distance from your gateway, we add repeaters to jump the signal over, if needed, to wherever the thermostats are communicating. So, that takes a little bit of time. But I would say just a standard number, we give eight hours, typically, to do a whole economizer.

That's a new actuator, that's the pearl, which is a component of the actuator economizer system, the thermostat install, programming, inventory – from start to finish, it's about an eight-hour process to do that installation.

If it's just a normal thermostat with no economizer, you could be in and out of there within an hour or two, if the gateway's already set up.

Hannah Kramer: Mm, great. Nico, could you flip back to your early-on cost-benefits slide where you show the total savings and total costs? There's a question about the 200k cost of the total investment. Does that include labor costs of your internal team, or is that, like, the hardware and infrastructure costs?

Nico Fauchier-Magnan: It's all of the above. So, it's hardware, labor, and infrastructure, I believe. And granted, it's not that easy to keep track of all those costs really well, so, you know, it's in the ballpark, I would say. Maybe the real cost is more like 250 or 300. But it's that order of magnitude, for sure. It's not much more than that.

Hannah Kramer: On the savings side, these are rolled-up savings. What was the variability, maybe, you saw between when you did 120 buildings? I know you didn't monitor every single one, but you kind of knew what their base case, maybe, was coming in.

Did you have some that were running really well, or for an owner who might not be doing 120, they might be doing 20, what's the variability they might see in savings per building?

Nico Fauchier-Magnan: Yeah, there is definitely some variation across – from one building to the other. I would say it's pretty rare to find a programmable thermostat that is correctly programmed with the right date and time, and where that gets maintained over time.

So, your base case is, more often than not, going to be longer run hours than what's needed, and probably less comfort that what you would expect. But yes, there is definitely some variability, so it's kinda hard to say.

I don't have the numbers in my head of percentage, but you would probably get at least 10, 15 percent at the very least in savings, and up to 40 percent we saw for ATCR, I think. That's pretty typical core range.

Hannah Kramer: Can you flip to the 40 percent? I'm trying to remember – that was of HVAC, not of total?

Nico Fauchier-Magnan: That's actually the total building.

[Crosstalk]

Hannah Kramer: Oh, that's total building.

Nico Fauchier-Magnan: Yeah.

Hannah Kramer: At the meter.

Nico Fauchier-Magnan: That's looking at the electric meter.

Hannah Kramer: Wow.

Nico Fauchier-Magnan: This is a heat-pump system, so there's no gas consumption. So, it's electric both for the winter and the summer. But yeah, that's, like, whole building savings. So, yeah.

Hannah Kramer: Wow, that's a lot. That's including lighting and everything?

Nico Fauchier-Magnan: Yeah.

Hannah Kramer: Okay. All right, so, a question on costs and justifying costs. Now that you have SWARM up and running for this big portfolio, is it just treated as a part of ongoing operational costs, or do you need to justify every year through your energy or maintenance cost savings? This also may be a point where you could mention how much you paid for the software hosting fees per site. Oh, you're on mute, yeah.

Nico Fauchier-Magnan: Yeah, sorry, I was trying to go back to my slides.Yeah, I think – so, the ongoing costs for this platform are pretty low. Our subscription cost is $3.00 per thermostat per year, so that's really affordable. So, we don't really have to justify that too much.

The ongoing costs are obviously worth it in regards to the benefits we get from this. It's more when we do new building installs, that's when we have to think if it's worth the investment or not, and yeah, so far, it has definitely been worth the investment.

Hannah Kramer: Okay, great.

Tom Ryan: Hannah, it is also good to note that that $3.00 per thermostat is not necessary. There is a – you do have Web access to all of the system for free. The $3.00 is just for extended users, to have more users on board, a longer time of history, like, historical data. It's some added benefits, but it's not necessary to have the system.

Hannah Kramer: Mm-hmm. So, the majority of the cost is the hardware and the setup and the gateways and that kind of thing.

Tom Ryan: Yeah, once you're set up, it's pretty low.

Hannah Kramer: Yeah, okay.

Nico Fauchier-Magnan: That might vary with vendors, too. So, that is something –

Tom Ryan: Right.

Nico Fauchier-Magnan: – you should look into when you're selecting your vendor. That's one more criteria to ask about.

Tom Ryan: Yeah.

Hannah Kramer: Mm-hmm. Okay, great. Here's a question about the optimum start function that you mentioned in your demo. Have you found that that works well? Historically – I guess this is coming from operators don't like to yield control of that start-up time. Has it proved to be successfully implemented?

Nico Fauchier-Magnan: Yeah, it works really well. We can actually go – let me see if I can do this real quick.

Tom Ryan: Nate, have you seen any issues with that?

Nathan Cardoza: No, it's an algorithm, so it's not gonna hit it right on the head right away. It needs to understand and learn how quickly the building reacts when the call happens. So, there is a few days of a learning curve. But overall, I would – I use it, so it is successful.

Nico Fauchier-Magnan: Yeah, so this is for the building we were looking at just this morning, just see. At 7:00 a.m. it was right on target at 68 degrees, and it had to start the system at 6:08 in order to get there. But that's pretty typical of what we see. It knows, really, how well the building responds.

Hannah Kramer: Mm-hmm. And otherwise, you might –

[Crosstalk]

Nico Fauchier-Magnan: And that's –

Hannah Kramer: – worry and start it at 5:00, right? So.

Nico Fauchier-Magnan: Right.

Hannah Kramer: Yeah. Great. So, in terms of future looking at the system, what capabilities would you like to see developed? I know you guys have developed some things internally that are kind of above and beyond. So, I guess I would say you have some ideas in this area.

Nico Fauchier-Magnan: Yeah, I mean, there's some nitty-gritty aspects of the platform, of our vertical platform that we'd like to see improved a little bit. Like looking at the network map is not super easy over time. Or it's kinda hard to maintain the network map as you add more buildings to it. So, that's one really kinda detailed thing that we'd like to improve.

But other than that, big picture, I think from an energy perspective, it gives us a lot. Yeah, it – I can't really think of.

[Crosstalk]

Tom Ryan: I mean, we pulled data into PI and we get a lot – we pull a lot more data out than they show you. They'll give you two weeks of data that they'll show historical graphs on, but we can pull a year of data, or whenever the thermostat was initiated a year ago, we can pull up to a year worth of data into a CSV and then do with it what we want.

For a bunch of mechanical engineers, that's like a playground. So, I would say that's a good thing that we do sort of with our own programming. We also have our own holiday shut-down scheme that we do.

We do kind of bulk programming in Python that we can implement. So, that's something that we kind of do a little bit above and beyond what the system is really designed for. They have ways to do it; it's just we – I don't know, I think the engineers kind of geek out and say, you know, we can do that better. So, I think they do, and they like to.

Hannah Kramer: So, great. I think we're running out of time here now, but I know your parting words of wisdom have been kind of throughout all this around make sure you talk to your IT folks early and often, and get things hammered out. Do you have any other final parting thoughts before I close out this session?

Joshua Morejohn: I would just say don't assume that your programmable thermostats are being used correctly, and if you have programmable, standalone thermostats in buildings, it's a great opportunity to put in a network system and get some really easy benefits.

Hannah Kramer: Great, yeah, it's another low-hanging fruit.

Tom Ryan: And one other thing to mention about our system, and I think some of the others', probably, as well. The gateways – when we're doing permanent installations, we do our Ethernet gateways, but if you are doing a sort of off-grid or a traveling kind of thing, you can do a cell gateway as well, to have your system be operable.

If it's more of a maintenance issue as opposed to an energy issue, and you just need to know what's going on in that particular building and you can't get an Ethernet connection to it, it's possible, it's just not as cost-effective, because you have a data plan that you have to get onto. So, if energy is not the only thing, and it should be part of it, I should say that, but just wanted to throw that out there.

Joshua Morejohn: And that would bypass most of your IT restrictions.

Tom Ryan: Also yes.

Hannah Kramer: Great. Well, thank you so much. To all the folks on this call, like I said before, we're having a renewed interest in addressing small building controls and analytics, so please do reach out to me – my email's right here – if you wanna talk about your ideas on how DOE can help move this area forward in terms of their role in better buildings and supporting owners.

We also have the email for the UC Davis SWARM team here, and I'll put in a plug – if you wanna be on more of these webinars, we have about one a quarter, you can join the EMIS tech team list at EMIS@LBL.gov, and we'll make sure you get those webinars.

We have our next one coming up in March on scaling up fault detection in a portfolio. We have Kaiser Permanente coming in to talk about their very large FDD implementation. And just a reminder on the different better building solutions center resources that we're here to help you with as well.

So, very big thank you to the UC Davis crew. They did an excellent job. And thank you for all your questions. We had a lot of great Q&A, and we will provide those in the follow-up email, because the UC Davis folks wrote very great, detailed answers in that Q&A. Thank you again, everyone, and have a great day.

[End of Audio]

Additional Speaker Q&A:

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

Additional Questions

Audience member: How did you select Pelican Wireless Systems?

Speaker: One of our main challenges was finding a system that could work with the campus network and the security concerns on a campus - we don't have an equipment Wi-Fi network so residential type systems don't work, and we needed a system that had its own gateways and networking capabilities.

Audience member: Small buildings are usually not good candidates for traditional BAS. Did you ever estimate the cost to install at these buildings? (for comparison to the $200,000 investment for SWARM?)

Speaker: Right - it would be cost prohibitive to bring them on to our campus BAS - this is essentially a very low-cost BAS system for small buildings. Per building it is a few hundred to a few thousand dollars to set up this system and probably 1/10 of the cost of a traditional BMS. The majority of the buildings we've done have had existing stand-alone thermostats and we replaced them with these networked ones, though a couple new buildings have been specified with this system instead of stand-alone thermostats now that we have it as our standard.

Audience member: Are the IT requirements that influenced your product vendor decision - still in place today?

Speaker: Yes. And they won't be going away anytime soon - security requirements are going up.

Audience member: Does UC Davis have an enterprise BAS (server level across the building fleet) and can Pelican be integrated into that system?

Speaker: We have a over 100 large buildings on a Siemens BAS system and another 20 or so on an ALC system. We have not had any reason to tie Pelican into those, but we did integrate it into our data analytics system for trending and FDD (we use OSIsoft/Aveva PI system and Sky Spark).

Audience member: Why the need for your "own" DR?

Speaker: Good question. We are currently not eligible for traditional utility DR programs (for complicated energy procurement reasons), but we still wanted to respond to high energy rates from the real time market. We are pushing "DR" events when the market electricity rates are above $200/MWh.

Audience member: Does Pelican have other control modules, e.g. lighting, that can be connected, integrated and controlled through the same gateway?

Speaker: Pelican does have a number of different control modules, but we have kept it simple for the most part.

Audience member: Where are the 40% savings are coming from? From better scheduling? What was the baseline setpoint schedule, and how does the new schedule differ from the baseline?

Speaker: The savings will vary from building to building, as each small building has a unique control system. Most were simple and either not programmed at all or badly done. The savings we report are based on our metered buildings and modeling.

Audience member: Is there a system application for single family dwellings? If yes, what are the benefits to the homeowner?

Speaker: If you mean Pelican, it can be used on a single-family dwelling or scaled to commercial spaces. They have a lot of customers who own hotels and stadiums, for example.

Audience member: Variable speed equipment (fans, compressors), often require a communicating thermostat to function or achieve higher efficiencies (i.e. minisplit). What have you done for this equipment, or have you only applied to equipment with electromechanical controls?

Speaker: We have only used it for equipment with basic controls (not VRF) but the economizer controls does have VFD capabilities.