[SQUEAKING]

[RUSTLING]

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MODERATOR: And our next speaker is Eric Bosworth from Eversource Energy. And he has collaborated with Eversource in the Framingham site, acquiring temperature data down the boreholes.

ERIC BOSWORTH: Hi. I'm good. I am the privileged individual that gets to run anchor here before lunch. So thanks for bearing with me. For those of you that I don't know, my name is Eric Bosworth. I work in the Clean Technologies Department at Eversource.

And for better or worse, I have had the privilege of overseeing the Framingham project from before site selection. So I joined on to the team to oversee it as we were figuring out where and how we were going to do this and all the way through today, when we are up in operation with customers using the system. So folks have talked about the project a lot over the last day and a half here.

I don't need to go over Framingham necessarily. What I'm hoping to do is bring the perspective of we've had a lot of insight into, what's the big picture? What's the policy direction we need to go into? How do we design a system like this? How do we operate a system like this?

I'm going to bring you the perspective of what happens when you get out there and start tearing up pavement and actually putting it in. Because nothing really prepares you for that until you're into it. And there's certainly some lessons learned and scars along the way that you pick up.

Here's a basic breakdown of the three main work streams that go into actually building a shared thermal network in a community. You've got the ground exchanger. Brock was just talking about drilling. We've talked about thermal conductivity testing and how the ground exchanger works.

It's pretty straightforward, but that's your energy source. You're putting holes into the ground. You're pulling heat out in the winter. You're putting heat in the summer. That's what's fueling your network.

But the other pieces are just important. You have the distribution loop, the pipes in the street, the service lines that you're pulling into the homes. How do you move the energy through the neighborhood?

And then finally, the building conversions, certainly not third in importance here. What are you doing to the building envelope, and how are you interfacing with that thermal network? How are you keeping your customers warm in the winter, cool in the summer? And what equipment is involved there?

So stepping through each of those, I like to start with main installation pipes in the street. Because as a utility, this is our bread and butter. We put in hundreds and hundreds of miles of this HDPE pipe every year. We know this.

We know how to open the street. We know how to fuse pipe. We know how to get it into the ground. We know how to test it, to the points that Mark brought up, making sure that the fusions are good and the pressure testing is appropriate and documented.

This part of the project was, I will say, the smoothest part from a timeline, a cost, an execution standpoint. Our crews know how to do this. We actually took crews that had been putting gas pipe in the year before, did a little bit of retraining on them, showed them how to stencil geothermal on the side of the pipe, and they were off to the races.

They got out there, and they installed all of this mile of pipe, plus all 38 services, in about two to three months. It was great. It was exactly as we planned it. Similarly, the service lines, just like a water service or a gas service or anything else that you would pull to a home, we dug a trench.

There's two lines in this case, instead of one. So we have a send and receive line. But for the most part, it's all the same materials. It's HDPE pipe that we're fusing. We're pulling it into the home. We're putting it into a pair of shut-off valves on the inside of the basement.

And it feels just like utility work. Even from the outside, if you watched a crew doing this trenching, repaving in the street, you'd have no idea that they were putting geothermal in. It just looks like everyday utility work.

So these two work streams, great, fantastic. We understand them. We do them all the time. They were easy. Borefield drilling? Eh, not necessarily a utility's forte. I think this is one of the first times that at least a gas utility in the nation has drilled boreholes, and there were some lessons learned.

Brock talked a lot about this, so I'm not going to harp too much on drilling specifically. But there's questions about site layout and what formation are you drilling in. How quickly can you drill? How do you manage your water and your cuttings?

We were learning. We brought in experts. They did a great job. They designed great ground exchangers. They executed well. But for us, as the utility, it was more a learning opportunity than anything. We certainly weren't out there directing the drillers on how to run their operation.

We were letting the experts do what they do best. And then in the future, we look at Framingham. We potentially have an expansion coming up here in the next year or two. And we've learned some lessons from the first time around that we will apply the next time we go out to drill a borefield.

And hopefully, we can do it quicker, we can do it more cost effectively the second time around. Just to talk a little bit to the pictures here, there's a lot going on. But we did take advantage of some of those nice deviated drilling techniques on our project that you can see here on the left.

And then on the right, that's what the manifold looks like when you come out of a borehole. So once you've got all those holes in the ground, you got to tie them together with pipes. So you pull all of the inlets and outlets together into a single vault.

You have a nice, long header for each of them. And that way, you can control the individual borehole runs. You can turn them on and off with valves if you want to. You can pressure test them. You can make sure that the system is on and running appropriately before you cover it back up.

Because again, Mark mentioned this multiple times-- but you really, really want to make sure that there are no issues or leaks before you backfill these systems. The pump house, kind of similar to the distribution loop. But this is the only above-ground structure on our system.

We chose to do it as a prefabricated building. So we came in, and we laid a foundation. We had as much of the mechanical work and piping and electrical done as we possibly could beforehand and then dropped the building down on top of the foundation afterwards.

And really, all it does is it's got the central pumps. It's got our control system, and it's got a little bit of backup in the sense that we have a central boiler in there, just in case we need to add some heat to the system. It was designed to not need it. But as a utility, the very first time out, we want to make absolutely sure that there are no problems with the operation of the system.

That comes back to customer perception and could affect adoption long term. So for our project, it also now serves as a very nice area where, when we come out and have tours, we can talk through some of the equipment involved and how the system works. It's really paid dividends to end up going above ground in this case.

We won't necessarily always do that. Looking to future iterations, we may volt pumps. We may bury things if we don't have the space to do it. But at least in Framingham, the pump house was a critical part of the loop.

Finally, getting into building conversions. This has by far been and was the most challenging part of getting a system online and running. Having the loop in the street, having it on and running, we kind of knew what we were getting into.

It wasn't necessarily all skill sets that we were familiar with, but we knew what to expect. Building conversions, every single one, you have no idea what you're getting into when you get into that building. We found mold. We found asbestos. We found knob and tube wiring.

You name it, we found it in one of these homes or buildings. And that may be somewhat unique to the building stock here in the Northeast, but it's a reality of large retrofit projects. You're going to have to tackle these types of problems.

So from an execution standpoint, we really tried to individualize it for all of our customers, get into their home, explain exactly what we needed to do, how we were going to do it. We ran ducting. We did about 15 to 20 main panel upgrades in this neighborhood.

So it wasn't just, how do I put a heat pump in? That's generally pretty straightforward. You get the unit in. You may need some ducting. You may need to adjust the existing ducting in the room. But the rest of the building is important too.

Are we air sealing? Are we weatherizing? Are we upgrading electrical systems? So the whole picture ends up playing into what the building conversions look like. And we demonstrated virtually every type of conversion, as well, on this project that you can have.

The good news is there's equipment out there to tackle almost all of it. Most of the residential homes were using forced-air systems. So we came in. We put a heat pump in. We distributed it with ducting and air systems.

The commercial buildings, we had rooftop units that we could actually just lift their old unit off and drop their new unit on top of the roof and reuse all of the existing distribution system in the building. And then we had some more niche applications, things like console units that look almost like one of those hotel air conditioners that sit under the window. We put those into a number of the subsidized housing apartments on this loop as well.

And just to emphasize that it's not necessarily, will it work? It's, how do I make it work with every single one of these? Finally, overall project management. I talked a little bit about this on building conversions. But making sure that we were having a very detailed and customer-focused approach through the entire project was important too.

As a utility, generally, we stay in the streets. We're putting pipes. We're pulling them. There's a demarcation point, and everything downstream is usually the customer's responsibility. Not in the case of this project.

The scope of our pilot approved by the department was including all of the building-side equipment and work. So we had to manage that part of the project as well. We were meeting with the customers in the field. We were explaining things.

We were having them look at exactly what was going in, where it was going in. We were getting feedback on things like, I'd like the ducting over here versus over there. Can you box it in with drywall? Can you paint it after the fact?

All of these little details that make project management very challenging. But it's extremely important. Because at the end of the day, I want these customers to have a good experience. I want them to like their new systems, and I want them to tell all of their neighbors about how great it was, as well, because that's how we grow the system and get adoption to continue.

Summing up the construction side of things. Timeline and parallel work streams. If I were to go do this project again, there are a lot of levers I could pull here for having simultaneous jobs go on so that my overall timeline could be shrunk.

I think in the second iteration, I could probably trim about 25% to 30% of our schedule off if I was going into it knowing what I know now. There are always the traditional utility challenges. We ran into buried infrastructure that wasn't on any map, wasn't on any diagram.

And you're digging along, and all of a sudden, you see a wooden conduit in the street. So you got to navigate around it. You have to make some on-the-job decisions, some on-the-fly changes to your system. Those were manageable.

There were some geothermal-specific challenges. The drilling went well, but there was a learning curve there, the geology. What type of drilling we were using? We tried air hammer. We did mud rotary. We kind of traded off to decide what was exactly the best way to drill in this specific neighborhood.

And then on the HVAC side of things, to this day, I'm still helping customers dial their systems in. So it's not necessarily, as soon as everything is installed, you walk away and it runs perfectly. There is definitely a period of adjustment and improvement and optimization that you can make.

Site access and scheduling. This was actually something that ended up affecting us quite a lot in terms of overall project schedule. But the reality is you're installing these in a community. It's people's yards. It's people's homes. It's school property.

And so when you're first planning the project, you're not necessarily thinking about, ooh, maybe they're not going to let me drill or have access to the school property in the fall, as everything is ramping up and students are all coming back. Individual customers, they go on vacation. They have their own lives. They have their work schedules.

So you have to really work around all of the individual pieces to get everything to come together. Otherwise, you find yourself sitting and waiting and saying, well, I guess I can't get access to the site today. Let's wait a week until I can. And that has impacts on the overall job.

Finally, I mentioned these, but unknown building conditions. I'm going to mention it again because it was such a challenge on the project. Really taking good stock of what buildings are in your planned community or planned area, understanding what some of the common things that you may encounter are, and having a plan for it ahead of time.

Asbestos remediation delayed some of our building conversions a good three to four months in this case. We got into, specifically, the low-income housing apartment buildings. We realized there may be some asbestos in the joining compound and the walls that they had used to construct those.

And it was about a four-month process to test every single unit, document it with the state, come up with a remediation plan, have that plan approved, and then have qualified contractors come in, set up all of their air containment, and do that remediation so that we could actually install the heat pumps. So it's those types of things that when you're in the initial planning stage, if you know there's a chance that these buildings may have asbestos in them, go ahead and test it during design.

Come up with your remediation plan. That way, when you're into project execution, you've got it all baked into the schedule, and it's not going to delay that particular part of the project. Moving on a little bit to commissions and operations. Because as I said, once the system is in the ground physically, that does not necessarily mean it's up and running.

A lot of lessons learned and challenges here as well. These screenshots here below are from our real-time SCADA system. There was a great discussion earlier around optimization and control and feedback on how you run and operate one of these thermal energy networks.

That's what we did. We had a SCADA system set up so that real time, anytime of the day, I can see what my pump speeds are. I can see my temperatures. I can see my pressures. I can see customer behavior based on the historic temperature trends.

So getting that system up and running was almost step one. Before I could even add a single customer, I wanted to be able to see the system remotely in a web-based SCADA. In addition to that, borefield flushing, pressure testing, getting air out of the system, these are all steps that we had to take as we turned it on, as we started the pumps up, and as we added customer loads to make sure that there wasn't any disruption in service.

Because the last thing that I wanted was to add a customer and then shut them down immediately, right thereafter and say, ooh, something's wrong with the system. Hang on. Let me address that, and we'll come back in a few days and turn you back on.

So a lot of work went into making sure that the system was on, stable, free of air, running properly before we could add customer loads. And then on the building commissioning side, once the loop is on and running, now you got to turn the buildings on as well. So that followed a very similar process.

But it was about getting the equipment in, making sure the electrical work was done, the plumbing work was done. You then have to pressure test everything on the building side, as well, because the last thing you want is a leak in one of these pipes carrying water and some glycol, in this case, that's going to flood a basement, flood a room.

Again, the perspective there from the customer, it's not going to be a very good one if you have to come in and say, sorry, I just flooded your basement. I'm going to pump it out, but let me try again. So a lot of testing, getting the equipment on and running, and then opening those valves and actually tying it into the main loop and making sure that it's getting energy from the system.

One of the challenges that I faced is, because we were reusing traditional gas contractors, they had a perception around how you should handle valves on this system. In their mind, open valves are good. You want every valve on the system open because in a gas system, that's what you do.

You open everything up. You've got flow. You're great. I had to go through that entire system and check every single bypass valve that I had because 75% of them were left open. What that means is, when I turn a customer system on, they're not exchanging fluid with the loop.

They're exchanging fluid with themselves, and their systems very quickly cool down. They shut off. They throw an error. So it's those types of things in troubleshooting through the commissioning that, the next time around, I'm going to be totally sure every bypass on a system is closed before I turn a customer on.

So lessons learned. Procedures and compliance. I cannot stress enough how important it is to know what you're doing before you do it. Have a documented procedure. Make sure you check it with your engineering team, your external engineers, experts in the industry that have done this before.

Have them look at it. They're going to have some great feedback. Valve positioning. Don't need to harp on it again, but it's very important. Loop flushing and purging. The biggest issue that I have seen on our system, at least, is air.

There's a procedure. There's a flushing procedure. But there's always a little bit of entrained air in these systems. And so getting it out is extremely important because it can shut down customer systems. You got to come out.

It's a trouble call. You purge the air. You start them back up. So definitely a step you don't want to shortcut or miss. Troubleshooting systems. Fortunately, as we've gone into operation here, the problems have decreased dramatically.

We're having less issues, errors, reasons that we need to go out and address things. But you always need to be ready to do that, especially at first. And then finally, I threw temporary space conditioning in here because on the theme of scheduling and having work done simultaneously, the way our project played out, you didn't necessarily have every single building ready to just be turned on straight away.

There was a process for building conversions. So we actually had to have a plan in the schools, for example. When we were pulling those rooftop units on and putting the new ones back, how are we keeping that space conditioned?

Do we have temporary air conditioners? Do we have temporary heaters? So all playing into the whole project management and logistics of a system like this and how you actually build it and turn it on.

Going forward, I have a laundry list of things that I'm going to be able to address the next time around and head off. So with that, hopefully I stayed on time. And we've got a little bit of time here for Q&A.

[APPLAUSE]

MODERATOR: Thank you.