Amy Hollander: Good morning. I'm Amy Hollander with the National Renewable Energy Laboratory. Welcome to today's webinar on monitoring residential geothermal ground source heat pump systems, sponsored by the United States Department of Energy.

I'd like to begin by thanking all of you on the phone for joining us this morning. We're broadcasting from DOE's National Renewable Energy Laboratory's brand new, state-of-the-art, net-zero research support facility in Golden, Colorado.

Our presentation today is designed to assist sustainable energy resources for consumers or SERC grantees and DOE project officers in monitoring SERC technologies.

Although this webinar can be useful to anyone inspecting residential systems, it is intended to inform SERC grantee inspectors and DOE project officers how to identify proper quality, functionality and long-term durability of ground source heat pumps, geothermal ground source heat pumps.

We are going to give participants a few more minutes to call in and log on, so while we wait, I'm gonna go over some logistics, and then we'll delve into today's topic.

So first of all, today's presentation will be posted online within ten days to two weeks. You will be receiving a link to the presentation via email at the end of the webinar, but remember the presentation will not be published or at the link for ten days to two weeks.

For now you have two options for how you can hear today's webinar. In the upper right-hand corner of your screen, there is an audio pane. If it is not visible to you, look for the red arrow and click on it. Opening this red arrow will allow you to choose whether or not you want to listen to the webinar through your computer speakers or by dialing in through your telephone.

As a rule, if you can listen to music on your computer, you should be able to hear the webinar. Sometimes the volume is not loud enough through your computer, so you can dial into the telephone number and pass code to hear the webinar. The phone number and pass code are in the audio box.

If you have questions during the presentation, please go to the same box in the questions pane. There you can type in any questions you may have during the course of the webinar. We will then strive to address your questions at the end of the webinar during the question-and-answer segment of today's presentation.

And with that, I'd like to introduce today's speaker. Today we will be hearing from Dave Peterson who is a project leader at the National Renewable Energy Laboratory.

David Peterson provides technical support to programs under the US Department of Treasury and US Department of Agriculture. Dave has provided presentations on geothermal heat pump technology to various audiences, including DOE's Tribal Energy Program, Iowa's Office of Energy Independence, and Massachusetts Department of Natural Resources. With that, I will turn it over to Dave Peterson.

David Peterson: Thank you Amy. Thanks, everyone, for joining us. Again, this presentation on geothermal and ground source heat pumps. I will be using the acronym GHP to represent ground source heat pump. I will probably refer to them as ground source heat pumps 'cause that's the way I typically refer to them, but there are a number of different names you'll see this technology under. Geothermal heat pumps, geoexchange systems, ground source heat pump systems. They're all referring to the same technology.

This slide basically shows the general structure of what we're going to cover in this presentation. What is the ground source heat pump system? Again, GHP I'm referring to as the ground source heat pump system.

How does the ground source heat pump system work? What are the different types of ground source heat pump systems? Where do ground source heat pump systems work? What are ground source heat pump system considerations? And then how do you evaluate a ground source heat pump system installer? And then finally, I will review the checklist. I'll just briefly go over that and emphasize important points in the checklist.

So before we get started really diving in, I just want to clarify something. What is a ground source heat pump system, and how does it differ from other geothermal technologies? And this is an important sort of distinction to make.

You'll often hear geothermal energy or geothermal systems all lumped under one category, but there are three distinct types of geothermal technologies that are very, very different. What we're going to talk about today is the ground source heat pump system. Again, I'll be referring to it as GHP in the rest of the presentation.

And these systems are used for space heating and cooling and domestic hot water. They can be installed in commercial buildings, and they can be installed in residential structures.

The second type is a direct-use system where you're literally pulling hot water out of the ground and using that hot water to heat a structure.

And then the third is geothermal electricity generation or geothermal power where you're actually using hot water pulled out of the ground. The water is so hot that it actually generates steam that can turn a steam turban and generate electricity.

And I have three pictures here. The one on the left is the ground source heat pump system and shows the loop field being buried underground that will be used for the heating and cooling of a structure.

The middle picture is a direct geothermal system where this is a nursery, I believe, in New Mexico that uses hot water pulled out of a well nearby that is heated to a – that is already hot enough that it can provide space heating for the structure. So it's directly using the water and heat in the water pumped out of the ground to heat this nursery.

And the right picture is a picture of the geysers in Northern California. I don't know if anyone's ever been – it's in Sonoma, just north of ____ Calistoga. It is the – I believe it's still the largest geothermal power system in the world, and it provides a huge amount of power to the California grid.

And it is basically using super-heated water found in geological formations underneath the hills in Sonoma to generate electricity directly. And again, the two on the right are very site specific. You have to have the right geological formation, the right water conditions to make those systems work.

What I'll talk about soon is that ground source heat pump systems are able to be installed in a wider range of areas and is a much more common technology.

So what is a ground source heat pump system? This is just a general description of what we're referring to here. It's an electrical-powered heating and cooling system that uses the relatively constant ground or ground water temperature to transfer heat – or energy for heat – energy or heat for space heating or cooling or heating hot water.

And so in heating mode – these systems provide both heating and cooling. So in heating mode, they transfer heat from the ground or ground water into the building. In cooling mode, they transfer heat from the building and reject it or put it in the ground or ground water.

And so how does a ground source heat pump system work? This is a basic diagram of the components of a ground source heat pump system. So you have three basic components of a ground source heat pump system.

You have the external loop field, and in this picture, it's shown in the bottom right-hand corner where you've got the blue and red piping running underneath the ground. That it's basically this piping or tubing buried underground that has a heat transfer fluid flowing through it. That's the external loop field.

And then you have the second main component - the heat pump unit itself, which includes an evaporator, condenser, compression, expansion valve, refrigerant all in sort of one contained unit that would be located inside the house, inside the structure, probably in the basement, much like any furnace.

And then you have the interior sort of HV/AC distribution system. How are you getting the heating and cooling distributed through the house? And these systems can either be ductwork or radiant floor.

Often, if it's a radiant system, your ground source heat pump system would only provide heating. It wouldn't provide cooling. If it's a ductwork system where you're basically replacing, you know, the forced-air furnace and the AC unit, it would provide both heating and cooling.

Essentially, the ground source heat pump system is not terribly different from an air source heat pump unit, which are much more common, except in the fact that you're using the ground as your place where you're deriving your heat or dumping your heat. In an air source heat pump system, you're using the outside air.

And this pretty much provides – this is the reason why ground source heat pumps are more efficient than air source heat pumps because you're using the constant temperature of the earth rather than the sort of more variable air temperatures.

And so this is a basic diagram of how a ground source heat pump works. This is essentially showing the guts of a ground source heat pump unit or a heat pump unit. And these are the major components. Again, the loop field's on the bottom, which runs through the – it runs the heat transfer fluid through the ground, up into a heat exchanger.

And if you're in heating mode, that heat exchanger would extract the heat out of that heat transfer fluid and through sort of a refrigerant cycle, allow internal air of the house to be brought in, heated and then returned and distributed throughout the house through the air supply.

GHP are very similar, aside from the ground loop, very similar to other HV/AC equipment. And then you've got the thermostat that would allow the homeowner to control the temperature settings.

There are many different types of GHP systems. I'll focus mainly on closed-loop systems. So what I've got here is a diagram of all the different types of ground source heat pump systems. Classification is dependent on what type of ground loop of the system.

And so you've got a closed-loop system, which I've been somewhat eluding to in the previous slide, where you've got, essentially, a sealed tube buried underground or under water that circulates the heat transfer fluid. And that's somewhat of a contained system. And again, you're using sort of an antifreeze, a propylene glycol solution as a heat transfer fluid, in general, that, again, either pulls heat from the ground or rejects heat into the ground, depending on whether you're trying to heat or cool the structure.

The other type of system is called an open-loop system where you utilize ground water directly as the heat transfer fluid. Open-loop systems are generally more efficient – or are cheaper to install than a closed-loop system. They're generally probably more efficient. The problem is that they require very specific conditions for their installation, and so, therefore, they're not as common as a closed-loop system.

So for the rest of the presentation, I'm going to be referring to a closed-loop system. And I'll basically be detailing some specifics on closed-loop systems.

The first type of closed-loop system that I just really want to go over quickly consists of burying the tubing or the loop field underground and circulating heat transfer fluid through it.

So we've got a horizontally-oriented closed-loop design, which for most residential systems, this is likely going to be the design that you're going to see. And this is basically an orientation where you put the loop field – you bury it about six to eight feet deep in sort of shallow trenches.

I've got two pictures here on the bottom where you've got – they've actually put a – they dug a trench with sort of a backhoe, and they're burying it down into that trench. And that's actually the one on the right.

The one on the left is where it literally looks like they're digging out a swimming pool, so they're digging out a large section of earth, putting the piping on the bottom, and then they'll bury it. Again, you want to be six to eight feet deep, you want to be below the frost line. The deeper you are, the more constant the earth temperature is, and that helps with the efficiency of the system.

The issues with the horizontal loop field design is that it does require more land than the next type that I will be talking about. And it's more applicable to smaller buildings because you're going to need more space. If you had a huge structure, you would need a lot of land. And if you have land available, yeah, you probably can do it, but then you're also talking about the cost of excavating out, you know, a large amount of space.

These are generally less expensive than the next type we're talking about, and they generally require less specialized skill and equipment to install. So a contractor would be more widely available to do this type of orientation.

The next type of closed-loop ground source heat pump systems is a vertically-oriented, closed-loop design. And this is a type of design where you're actually drilling essentially bore holes or wells deeper into the earth, and so we're talking 150-, 400-feet-deep bore holes that the piping is then inserted into.

The benefits of this is you're going deeper, so again, the earth's temperature is more constant the deeper you go, and so you've got less variability as you would with a horizontal system.

Generally, we're talking about higher installation cost on these. Even though there are vertically-oriented loop fields on residential structures, in general, these are for larger structures. If you would have a multi-unit housing development unit, that would be something that could use a vertical system, a vertical loop field.

You'd also be looking at this for schools and government buildings and things like that. So larger structures. Higher cost because of the drilling. You need specialized rigs to do this, and there's one on the left. The bottom left is a picture of a rig. And essentially, you're drilling these bore holes, and you're gonna – because of the specialized rigs and the drilling operations, you have probably a more limited availability of experienced folks to do this type of system, and you're looking at drillers and installers that really know what they're doing when you're putting one of these systems in.

And so the next question is generally, across the US, where do these systems work? We are looking at a graph here, essentially, I guess – let's look at the bullet points first.

These systems technically can work anywhere in any climate, but the soil conditions are very important to how these systems function and their performance and must be considered.

And so the graph on the top really just shows sort of annual operating cost. A lot of this has to do with how much it's gonna cost to operate the system. And so in Burlington, Vermont, it looks like you've got the first bar, the blue bar, essentially, a ground source heat pump system. The second bar is an air source heat pump system. And the dark red bar is a furnace with an AC unit.

And these are sort of annual operating costs per year for these different types of HV/AC systems. And you can see in Burlington, the ground source heat pump system appears to come out much cheaper on an annual basis, an operating cost basis than the other two.

But you can see in other places it doesn't appear to have much of an advantage cost wise. And this is a significant issue because the cost of installing a ground source heat pump system is significantly more than any of the other conventional HV/AC systems. And so it really depends on location of the system. I'll come back to this in a couple more slides to talk about the cost issue.

And this is just another slide, from the EIA website, where it shows the distribution of where ground source heat pumps are installed in the US. And again, this is a mix of residential and industrial and commercial systems, so it doesn't really tell you totals for residential systems.

But the Midwest and the South are primarily where these systems are installed. And likely, one of the main reasons is that these are all electric systems, so where power's cheaper, they make more sense. And in general, you have to have the right conditions, so apparently, in the South and Midwest, it's easier to install these things and to make them function properly.

And also, a lot of this could also be utility incentives and things that are driving those markets as well. And so this just gives you a basic snapshot of where these things are generally installed in the US.

And here are some general considerations when you're considering – when you're looking at a ground source heat pump system from a project officer standpoint or from any person's standpoint. Know the process, kind of what we've already gone over. Know the general process of how these things work. Know what to look for in regards to a residential system.

I'd like to point out one of the better sort of guides that are out there for a nonengineer, I think it's called the "Geothermal Survivor Kit". You can download it from a company called Heat Spring Energy that does a lot of training on ground source heat pumps, and they have this engineer update this. And so this is a really good link, and you can download this, it's like a 30-page, 40-page document that gives you sort of the lowdown on ground sourcing pump systems at the residential level.

Look at the site prior to installation. Look at – require a minimum system warranty. When we talk about a system, a problem with ground source heat pumps is that, you know, the heat pump unit is usually manufactured by a well-known entity and may have a defined warranty.

But you really want to make sure that the system, the loop field, the heat pump, the distribution system that it all works together and functions properly. So you want to look for a system warranty. Look for minimum – reference the minimum installation standards.

Use the IGSHPA (refers to the International Ground Source Heat Pump Association) as a resource. They are essentially the main body that policies installers. They certify installers and designers. They run the training courses. They are also somewhat of a lobbying arm for the ground source heat pump industry. So they have a vested interest in pushing the technology, but they also have a vested interest in making sure that these systems perform as expected.

The request unit pricing. Request design drawings. Understand what's being done, and make sure that the installer understands exactly how the system's supposed to be designed and how it's supposed to function.

I'm coming back to cost again because this is a major consideration. I can't emphasize this enough. Installation cost for ground source heat pump systems are going to be significantly higher than conventional systems. So the bottom graph shows the installed cost for a three-ton system, which is roughly the size of a system for sort of a fifteen-hundred- to two-thousand-square-foot house.

You can see the two bars on the left are the conventional HV/AC systems, and their install costs around $6,000.00. The first one is a ground water, using ground water, and you're up to $10,000.00. And then the three on the right are basically the closed-loop ground source heat pump system that we've been referring to, and those are you're looking at $12,000.00.

So you're looking at a cost premium of, you know, six-, eight-, possibly even ten-thousand-dollars difference for a ground source heat pump system. And the top graph basically illustrates why that's the case.

It's essentially the loop field. So the main difference between a ground source heat pump system and an air source heat pump system is that the loop field requires significant cost to put in. And so the ground loop is the major, you know, incremental cost difference between ground source heat pump systems and a traditional HV/AC system.

And so what are the major considerations in designing and installing a ground source heat pump system? It's sizing the system properly to the building that needs the heating and cooling. This cannot be emphasized enough. This is absolutely critical that the installer knows what they're doing when they're designing the system.

Your installer and sort of the experience of your installer installing ground source heat pump systems is probably the critical – the make-or-break component or consideration for installing a ground source heat pump system.

And so the main thing is to determine heating and cooling loads for the structure, accurately calculating the heating and cooling loads for the structure that you're looking at. Then you want to properly size and design the ground loop according to what the annual heating and cooling load that you calculated.

And there's software to help designers and installers properly size it. I highly discourage not using rules of thumb on sizing the loop field. You may want to ask the installers how did they size this system? What are they using to derive the size and the layout of the ground loop? And they should have a very good answer that's not sort of a quick math, well, the house is 2,000 square feet, and, therefore, we, you know – it needs to be much more specific than that. And I would say they would likely want to be using some sort of software to size the loop field.

And then also, you want to make sure that the circulation pumps hooked up to the ground loop are properly sized. If they're oversized, they use far more electricity than should be required. If they're undersized, they will not meet the heating and cooling loads of the structure. And then you also want to properly select the heat pump size for the structure and loop field that you're putting in.

So I pulled this list actually off of the International Ground Source Heat Pump Association's website, and this is how do you evaluate installers of these systems? One of the main things is that they need to follow the protocols established by the International Ground Source Heat Pump Association.

And again, these are only available for closed-loop systems. I believe they're still only available for closed-loop systems. But, you know, they have lots of literature and very specific guidelines for how to install a residential ground source heat pump system.

And ideally, these installers should be accredited by the International Ground Source Heat Pump Association or another sort of recognized institution. And, you know, a lot of manufacturers of ground source heat pumps, the heat pump units actually do trainings for contractors.

You know, ask for references. Check their references. If they say they've installed systems, get some references and find out whether or not those systems are working properly before you sign them up to install a system at a structure that you're responsible for.

Get estimates in writing and warranties, again, that don't just guarantee the heat pump performance, but the whole installed system. And then insist on sort of a written contract that includes all terms, costs, stop and start dates, things like that.

And what I've included here on the bottom are two directories that will link you to installers in most areas of the country. And so the International Ground Source Heat Pump Association's directory is very extensive. They've been doing this for a while. So you should be able to find an installer in an area near you, and that has done training or received a certification from this group.

And so what are key ground source heat pump system considerations involving sort of annual maintenance? And I think what I wanted to emphasize with this particular slide is that as with any HV/AC system, you would likely want to do some sort of annual checkup, but, you know, with ground source heat pump systems, in general, once a system's been installed, you're probably looking at similar O&M or operating maintenance that any other sort of HV/AC system would require.

And so, again, we're looking at, you know, making sure the filter's clean, making sure the fan – and making sure that the air – you know, we're talking about a forced-air system here. Making sure the ductwork has been inspected. You know, all these things are sort of for any sort of forced-air ductwork-type system you're talking about. This is sort of standard maintenance.

And so I would say the maintenance should not vary much compared to an air source heat pump or another sort of HV/AC system.

And so now, I'm gonna go just briefly over the checklist that was sent out. And again, we're talking about just the checklist that is requiring project information, inspection, and then an inspection checklist with pre-installation, installation and post-installation.

And so the project information, you know, again, we're looking at, you know, we want a general description of the system, size of the system, again, in tons, in one ton. The installer should be able to tell you what that is in tons, and if you want to translate that into BTUs, that's fairly easy to do.

The type of ground loop that you're putting in, I think that's a critical element. And then … installer, inspector. And then the performance test and date of the performance test is another sort of critical component of this checklist.

So the pre-installation checklist that was provided, you know, you're looking at, you know, the design and installation. Was it completed by a certified contractor, an International Ground Source Heat Pump certified contractor?

You know, are the system designs complete? Did they give you drawings? Are they detailed enough to where you know what the contractor's going to be doing? Is the system compliant with the codes? Did they pull the proper permits? And then are there sufficient warranties, again, not just for the unit, but also for, you know, installation and sort of operation of the entire system?

And, you know, the warranties for the heat pump units themselves, I think you're probably looking at maybe ten years, as a ten-year sort of limited warranty. In terms of sort of the ground loop and sort of the installation of the ground loop, the loop field warranty should be 25 years, 50 years long. I mean, that's just for what they put in the ground, what they buried in the ground.

And when you're talking about sort of the system warranty, a lot of the installers will probably give a one- to two-year warranty that the systems will function properly for those two years. And again, I think those warranties are going to vary, but, you know, I think any responsible contractor, installer will warranty a system for at least a year or two.

And so we've got the installation checklist, which, you know, talks very generally about the main different components of the ground source heat pump system. You've got electrical. You've got the heat pump, the ground loop. There's a number of – so the ground loop we're talking about is it installed properly again, according to the different type of orientation? They've got slinky, horizontal, pond, vertical. All these have different issues involving each one, and there are certain things that need to be paid attention to in installing each of those ground loops.

For the heat pump, you're looking at is it installed according to the work order? And then sort of are there any changes to the ductwork or the heat distribution system inside the house? Is that done according to the work order?

And then electrical. Again, you're just looking at sort of standard issues that you would have with any sort of HV/AC system. And so let's move on.

Post-installation. I have some of these things checked of. I found this a little bit interesting. The visual inspection prior to the burial of the loop, the ground loop. Again, I don't know who's going to be doing that inspection, but it's maybe tough to coordinate that with the installer. And then a visual inspection after the burial of the loop field.

The two pictures on the right are – the top picture on the right is a picture of an open field, and I used to say this is – and in one of the presentations I gave, I said this is what you'll see outside the structure with the ground source heat pump system. Basically, the loop field's there. It's just buried underground. You can't even tell it's there.

And so once the loop field's been buried, you probably won't even have any idea it's there. And so sort of any visual inspection post-installation will be tough to do.

And so, you know, again, it's one of the specifics of this post-installation. It may be difficult to do any sort of visual confirmation on any of this stuff, but you want to make sure that, I think, the contractor has done – can verify that all these things were checked off and, you know, pressure tested the group loop.

It's a huge issue for these ground source heat pump systems 'cause that will tell you when they buried the thing in the ground, if there are any leaks. Are there any cracks in the tube? Did they, you know – sort of the fused – the butts in the fused portions of the tubing, is that done properly? The pressure test would tell you right away if that was the case. And they need to make sure they do a pressure test in the ground loop.

And then sort of performance testing. You know, again, system documentation, ownership education. I think I – so system documentation. These are all the things that the checklist is requiring of folks. Again, you know, make sure the owner understands what they have.

Again, I don't think – you know, the basic operation of this system's not gonna be any different than someone having any other HV/AC system, except, you know, you may – if there's a problem that arises, you're gonna have to call someone that understands how these systems work, and it's likely not gonna be just every HV/AC company that can do that.

And so I think – so we got – again, so those are key points to remember. Verification of the installation is very important. Monitoring assists with the success of these installations. If you don't know what to look for, just ask the installer or ask someone, ask me.

Take a picture, document, document, document. If you don't know what you're looking at, take a picture. Document as much as possible. And then make sure that the client understands or the – I'm assuming this is the homeowner – understands what maintenance is going to be required for this type of system.

And so this is my contact information. If you want to contact me, feel free to do that. If I can't answer the question, I will refer you to someone that can. And I am now gonna turn it back over to Amy, and she will have – we'll have a little bit of a Q&A.

Amy Hollander: Thank you Dave. That was really informative and interesting. That concludes the slides for this presentation on monitoring residential geothermal in-ground heat pump systems.

For those of you who can stay with us, we have some excellent questions coming in from today's audience. The first one is – and I know this is tough to answer, but let's just say that you're looking at a system in the Midwest. How many years do you think it's gonna take to pay off that system?

David Peterson: And that is a tough one. One of the links I'll provide is a study that the State of Indiana they had a ground source heat pump incentive program, and they published sort of a little report talking about the cost associated. And that was very Midwest specific.

It's really about the incremental cost of your system versus a traditional system. How much does it cost to run that using electricity versus what you would have had to for your heat and cooling system otherwise?

The installers won't give you an accurate answer on this. The tax credits bring down the price significantly. There are federal tax credits, and there's often state incentives, often utility incentives that bring the cost of these systems down. I would say you're looking at, at least a ten-year payback.

Amy Hollander: And that is without incentives or –

David Peterson: I would say that's with incentives.

Amy Hollander: With incentives.

David Peterson: Yeah.

Amy Hollander: So since it sort of varies from state to state, would it be safe to say the payback is gonna be fifteen years? Would that be ____?

David Peterson: Yeah, I would – you know, you're looking over ten years. And I would say if you're under a ten-year – if you have an installer telling you that it's under a ten-year payback, show your math. Have him show the math and make sure that the assumptions that they're using are accurate.

Back when natural gas prices were very high, everyone – these systems looked great in a lot of areas 'cause the competing heating costs of a natural gas, forced-air furnace looked a lot better opposed to using electricity to power the system.

And in the Midwest, electricity prices are cheaper than they are in other parts of the country. So I'd say the Midwest, the reason these things are installed as regularly as they are is they're fairly easy to install, you're not talking about really rocky terrain, in general, you know, the thermal properties of the soil are advantageous to a ground source heat pump system, and then you're looking at, you know, lower electricity prices.

And so those are really what drive ground source heat pump systems. But from an efficiency standpoint, these systems are, hands-down, the most efficient, and when they're installed properly.

The issue really is how much are the upfront costs? And what's that incremental cost going to be over a conventional system?

Amy Hollander: So it seems like one of the biggest benefits is environmental. The emissions are zero. And it also seems like usually the incentives are high, and so it's probably gonna bring the payback down to an eight- to ten-year period.

David Peterson: Yeah. I would say best case is gonna be eight to ten. And, you know, it goes up from there.

Again, the cost of the advantage of a ground source heat pump system comes with the commercial-sized systems. And that's when they start really competing with conventional systems.

Amy Hollander: Okay. Thank you. Next question. When used for home heating or in residential, as we're discussing, is a backup heating system required?

David Peterson: Yes. Every system should have some sort of auxiliary heat that's integrated into the system. And most of the times, I would say, most of the times the systems I've seen they're using electric-resistance heater, a small electric-resistance heater that would actually kick on when the system became overwhelmed at really, really cold snaps.

But in general, if the system's sized properly, meaning the loop field adequate, you know, if the system is sized properly, that auxiliary system should not have to kick on. But most systems do include a backup heat source.

Amy Hollander: Great. Thank you. Under what conditions should you never install a ground source heat pump?

David Peterson: I think one of the main things is are you – is there a question that wherever you're putting the loop field, is that gonna ever be used for some other purpose? So, you know, if you have a field next door, next to you, a plot of land that you want to sell at some point, don't put your loop field there 'cause someone may want to excavate.

So essentially, is where you're putting your loop field. I think – you know, again, I showed the sort of geographical distribution of these systems. Again, they probably have been installed in every state. They just tend to work better, generally, where the soil conditions are best suited for ground source heat pump system.

But I would say, yeah, never install a ground source heat pump system when you don't know sort of the future of the space or the land where you're putting your loop field.

Amy Hollander: And what kind of activity can occur on top of the land? Can you drive on it? Can you garden on top of it?

David Peterson: Yes. Yes. Schools do this, and they basically put the loop field, and then they put a parking lot on top. You know, a lot of colleges are putting these things in. I think Ball State's got one of the largest one's now. And they put their loop field under the college green.

Ball State didn't really have a lot of space. They had parking lots. They put some loop fields under parking lots, and then they put big loop fields actually under the college greens, so the, so where in between the big college green area and the middle campus. So yes, you can – you know, that's fine.

Amy Hollander: Great. So how can you tell if the system is working? Say if you're in Tennessee or someplace where it's not very, very cold, do you have to rely on a utility bill or is there a monitor attached to the system indoors?

David Peterson: I would say most systems are – the monitoring is similar to that of your standard furnace. I mean, you really – if it's not functioning properly, it's either, you know, it's uncomfortable in the structure and that's how you would know or your energy bills are extremely high.

And so that's really – you know, a lot of the systems that NREL's looked at have been heavily monitored for sort of research purposes, but most residential systems are not gonna be monitored. There's not gonna be any way that you can – and most homeowners would not know what they were looking at anyway.

And so I would say, you know, it's very contingent on is it comfortable in the structure? You'll know. And then what are your bills looking like? And I think those are the two main ways that you'll be able to judge.

Amy Hollander: Okay. Thank you. And it also sounds like if something goes wrong with the system, it's gonna happen in the first few weeks. It's not likely that the system will quit working five years later because it's buried underground, it's probably – if something's not right, it's gonna show up right away.

David Peterson: Yeah, I would say that's the case. And again, I think the sort of the warranty for the whole system being one to two years should be adequate to work out the kinks if there are any to work out. And so yeah, I would say that, on average, repair cost on these things, once you get past that period, you know – typically, you know, one of the – the proponents of these systems say that the maintenance costs are lower.

The main reason maintenance costs are gonna be lower than your traditional sort HV/AC system is that you don't have any outside units. So if that loop field's underground and then everything is else within the system is inside the house so that the heat pump unit is in your basement, it's not like an air source heat pump where you actually have – or a condenser for an AC where you've got it outside and it's exposed to the hot and cold weather and climate cycles.

It's in the house, it's roughly at room temperature. And so, in general, maintenance is supposed to be less for these systems compared to a traditional HV/AC system.

Amy Hollander: So in terms of recommending maintenance to low-income weatherization clients, what would you tell them after their system's installed, assuming that it's working well?

David Peterson: Well, I mean, I think, again, what we just talked about, you know, look at the sort of comfort level within the structure. Again, if it's operating properly and it's up to your satisfaction, then I think general annual maintenance, and a maintenance schedule that you would have for any HV/AC system would be adequate for this.

And so, again, a lot of what you're dealing with, what's inside the house is not – it's very similar to what you would see with a conventional HV/AC system. It's not that different. And so the annual maintenance or the maintenance schedule that you would want a low-income person, you know, to follow wouldn't be any different. I don't think it would be any different.

I think the difference is if there is an issue, then you need to get someone, you need to call a contractor that understands these systems, and not every HV/AC company does that. And I think that's the point.

Amy Hollander: Okay. It sounds like you're not recommending annual inspection or an annual checkup. Pretty much these are maintenance free, unless they appear to be not – dysfunctioning.

David Peterson: Well, I have a forced-air furnace in my house, and I have someone come at least once a year, maybe once every other year to double check that everything's functioning properly. And just sort of just general service, having it generally serviced on a regular basis, I think, is wise.

Amy Hollander: I think that one thing, if it's not too late, to put in your RFP is to require that the warranty perhaps includes an annual checkup for the life of the warranty. And that's, I think, what we recommended in an RFP template that we did for ground source heat pumps. But just as a reminder, you might want to have the selected contractor follow through with this, that they – not a maintenance agreement, but just a warranty that requires that they verify that the system is working.

So the next question coming in is – let's see – are there IGSHPA-certified contractors throughout the United States?

David Peterson: I would say very likely that they are found in every state. Again, if there is someone selling this service that they, you know, can design and install a ground source heat pump system, they are very likely – they should have that certification.

You know, I think some – I don't know if they're doing it online nowadays, but they offer these classes on a fairly regular basis. You know, I think to error on the side of having a certified contractor is certainly in the interest of this weatherization program just because these guys have been at it for a long time, they've got a structure, they've been training folks up for quite a while.

And if you go on their website and go to the directory, I had the link on that one slide, and maybe we'll provide that link to everyone, that should give you an idea of the sort of range of installers that are around.

I really think that the references and sort of their experience is sort of the fundamental issue when you're evaluating a potential ground source heat pump system installer because just because someone got the certification doesn't necessarily mean that they are up to snuff to install a system and make sure that it's working properly. So I think the combination of those two is sort of the two critical components of evaluating an installer.

Amy Hollander: Great. Thank you. And then this particular question came in before you hit on this slide, but I'm gonna read it again because it is important. Would you elaborate on the importance of the correct sizing of the loop field and how that can negatively impact the system performance, say, if it's not sized correctly?

David Peterson: Well, again, the loop field, the whole purpose of the loop field is to pull heat from the ground or to dump heat into the ground. And so, you know, the larger the building, the more loop you're going to need 'cause you're gonna need access to more heat. Let's just talk about heating. You need heat to pull into the structure and to pull into the house.

If the loop field is not long enough, it will not be able to gather up enough heat to keep the structure heated to a point that's comfortable. If the loop field is too long – I mean, so it's really sort of – it will underperform if it's not long enough, if the loop field's not long enough. And it will – if the loop field's too long, you're talking about a system that will be far more expensive than it needs to be.

And so, again, the main driver of cost, the incremental cost of one of these systems is the cost of installing a loop field. And if you've oversized the system, you're talking about, you know, extra costs that don't necessarily need to be spent.

An installer that doesn't use a software, doesn't know the proper protocol to size a loop field may just use a rule of thumb, and they may oversize it, and it may perform well, but the cost of the system probably was driven up by that.

So again, an experienced designer and installer of these systems should be able to properly size it. That is a critical, critical component of installing these systems is making sure that whoever's installing it, knows what they're doing. And to make sure that these things function over the long term.

Amy Hollander: Great. Thank you. Going back to this question about the backup heating system, you were recommending an electric resistance heater for cold snaps or if something drastic would happen, that it wouldn't quit working.

So are you recommending removing the old heating system? So if the house has a forced-air system, would you recommend removing that?

David Peterson: Yeah. I mean, this is basically, you know, removing your old system, swapping it in for a ground source heat pump system. I don't know of hybridized systems. I don't think that that's something that happened. I think, in general, you're talking about this is replacing your furnace. This is replacing your central AC unit. You know, that's essentially the function of these systems.

I'm not totally familiar with, you know, possibly keeping different aspects of the existing system. And obviously, the main issue when you're retrofitting a building or a house is what's the distribution system look like? Are you talking about – are you gonna have to install ductwork?

That's a major cost driver on retrofits is do you have to completely – you know, if there's radiant – if it's a radiator, sort of a boiler system, are you gonna have to install ductwork for your ground source heat pump system? And that is usually the case with a lot of these. So, you know, ductwork expense is – putting in new ductwork is another big cost factor when you're talking about a retrofit.

Amy Hollander: So these systems work well using the existing ductwork of a forced-air heating system. And so that would be a good recommendation for –

David Peterson: Yeah. I mean, if there's –

Amy Hollander: – ____?

David Peterson: – yes.

Amy Hollander: Okay.

David Peterson: Yes.

Amy Hollander: Great. Thank you. I'm not seeing any more questions, but I want to thank everybody or these really engaging and really good questions. Dave, do you have any closing comments for the audience today?

David Peterson: No.

Amy Hollander: Okay. For those of you missed the beginning, I'll mention again that you'll be receiving a link to the webinar via your email, but it will not be posted for ten days to two weeks. Also, you will be receiving a thank-you for attending the webinar. And with that, I have asked Deb Lastowka to include the checklist that Dave referred to. I will ask ____ include the links that were discussed in the presentation.

With that, we will sign off. And I hope that all of you have a very good workday today. And thank you for joining us.

[End of Audio]