Amy Hollander: Hello and good morning. I'm Amy Hollander with the National Renewable Energy Laboratory. Welcome to today's webinar on Monitoring Residential Solar Thermal Hot Water 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 today. We're broadcasting from DOE's National Renewable Energy Laboratory's brand new state-of-the-art net zero energy research support facility in Golden, Colorado. Our presentation today is designed to assist Sustainable Energy Resources for Consumers or SERC grantees DOE project officers in monitoring SERC technology. Although this webinar can be useful to anyone inspecting residential systems, it is intended to inform SERC grantees, grantee inspectors, DOE project officers how to identify proper quality, functionality, and long-term durability of solar thermal hot water systems.

We're going to give participants a few more minutes to call in and log on, so while we wait, I'll go over some logistics and then we'll delve into today's topic. 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will be receiving a link to the presentation via email at the end of the webinar, but remember, the presentation will not be published or at the link for ten days to two weeks.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 on how you can hear today's webinar. In the upper right corner of the 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's speakers or 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 in to the telephone number and pass code to hear the webinar. The phone number and pass code are also in the audio box.

If you have questions during the presentation, please go to the questions pane in the same box. There, you can type in 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 Q&A segment of today's presentation.

And with that, I'd like to introduce today's speaker. Today, we will be hearing from Eliza Hotchkiss, who is an analyst at the National Renewable Energy Lab. Her background is in energy

efficient and sustainable architecture and water conservation. She works with organizations and federal agencies to reduce their energy consumption and greenhouse gas emissions within buildings. Eliza has also monitored certain projects in New York and Idaho on behalf of DOE.

With that, I will turn it over to Eliza Hotchkiss.

Eliza Hotchkiss: Thanks, Amy. Thank you all for joining us today. As Amy mentioned, my name is Eliza Hotchkiss and I'll be presenting today's webinar on solar hot water heaters for SERC technology overviews. The objective of today's webinar is to provide a basic overview of solar hot water technologies and then the post installation checklists that were created for the SERC program. Some of you may be familiar with those checklists.

To begin, there are two basic solar technologies that are typically installed on residential properties. The image on the top left-hand corner of your screen shows solar photovoltaics, commonly referred to as PV. PV uses energy from the sun to create electricity. The bottom right-hand corner shows a solar hot water panel which uses the sun's energy to heat a fluid which is generally used to heat domestic water supplies. The technology that we're talking about today is solar hot water, just to clarify between the two different technologies.

Within solar hot water, there are two basic types of collectors that are important to note. The image on the left shows a higher tech, high efficiency, and generally higher cost evacuated solar tube collector. On the right, you'll see a lower efficiency and lower cost flat plate collector system. The image on the right is also of a flat plate collector with a storage system. This gives you a visual of the two basic systems used within solar hot water heating.

There are a number of different elements that are included in a solar hot water system. First is the collector, so you can have flat plate or evacuated tubes, which we showed on the previous slide. There's a storage tank which is used to store the warmed liquid, piping system to direct the fluid from the solar collector to the tank or to your tap. You'll have controls, you'll need a transfer medium, generally glycol in areas where you have risk of freezing, or water within the solar collector, and then a method of circulating that fluid through the system, which can be either gravity fed or it can be pumped.

The diagram on the right shows the different components of the hot water system and most of the components come as a prepackaged system, however the pumping system and the fluids will need to be an additional feature if they're not included in the packages themselves.

A number of factors determine whether solar hot water is a feasible technology for a property. The availability of the solar resource or the amount of solar energy available at a site is really important. The efficiency of the collector system itself will vary depending on the design of the system and then the cost of alternative fuels, such as natural gas and fuel oil, will determine whether or not the technology is cost effective.

These two maps are something that we use pretty regularly at NREL. They show the availability of solar energy throughout the United States and also the cost of fuel across the U.S. The map on the left is a solar resource map. If you look at the different colors, this is showing the kilowatt hours per square meter per day on an annual average and if you look at Las Vegas, you can see that it has about seven to eight kilowatt hours per square meter per day compared to a state like Maine, which is in the northeast, that has a lower resource of about four to five kilowatt hours per day.

The map on the right shows you the cost of fuel, so if we compare Maine again, it has a high cost of fuel, about $4.00 per gallon of home heating oil, or in this Energy Information Administration map on the right, you can see the dollars per 1,000 cubic feet for residential natural gas. And Maine's gas prices range between $16.00 and $36.00. These are two really useful resources.

Other considerations when you're thinking about installing solar hot water systems include whether or not it's low profile, if you need it to be lightweight, if it's in an area prone to freezing, if you need low maintenance, if you need simple control systems, if it's in a retrofit potential area for storage or if you don't have storage, if you need to save space and don't have room for a storage tank, then those might be factors to consider.

This table shows the characteristics of system components in the left column and then the components themselves along the top row. For example, if you're in an historic area and need a low profile system, then you probably would not want to consider the thermosyphon technology because it's slightly more obtrusive and heavier. If you don't have extra space for an extra storage tank, it might be worth considering a thermosyphon system that pumps

water directly. This is an example of a table that might help you with all of those different considerations.

Drainback systems are the simplest solar hot water system to purchase and install and they require far less maintenance than most other types of solar hot water systems. Additionally, drainback solar hot water systems can be installed almost anywhere in the U.S. because of their simple, gravity-fed freeze protection, which is as efficient – or more so - as a pressurized glycol system.

Just to continue with the considerations, it's important to note that systems operate best with routine maintenance and we recommend that these systems be maintained on an annual basis. It's important to make sure that the unit has an automatic vacation mode or heat dissipater. Wherever possible, it's recommended to avoid custom designed systems and the reason for that is the custom designed systems may require a qualified technician for servicing. The issue with SERC is if you need a qualified technician for servicing, they may not be available or the funding may not be available for future servicing on those systems.

Also, systems are not intended to meet 100 percent of hot water loads. The basic rule of thumb is to use about 60 to 75 percent of the hot water load and this depends on the location and the system efficiency.

We recommend that you use a certified solar thermal installer and one certifying body is the North American Board of Certified Energy Practitioners or NABCEP. This map shows you different locations. You can go to the NABCEP website and click on a state and it will show you where there are local installers. And what's nice to know about NABCEP is that their certified solar thermal installers are those individuals who have satisfied the professional certification standards that have been established by NABCEP and you can also find those standards on their website.

Key considerations for systems are to inspect the site prior to installation to determine whether there's a lot of shading by trees or if the roof structure is strong enough to support additional weight of the solar hot water system. It's important to require minimum system warranties for both the panels and the system components. It's important to reference minimum installation standards, so if you're issuing an RFP (request for proposal), you might have a requirement that there be certified installers. It's also

important to differentiate between pre-engineered systems and custom designs for the reasons mentioned earlier.

Within an RFP, it's also important to specify this system's minimum solar fraction which can be found using one of those NREL solar maps that were shown earlier. Also request a unit price so that you have an overview of the prices available or the cost for installation from different installers.

These are some key considerations before you even begin installing a solar hot water system. Once the system has been installed, it's important to verify that the installation has been done and been done correctly. Many SERC sub-grantees were asking what kind of verification items were needed after installation and as a response to those questions, checklists were created to assist with the verification process. These are intended to be used as guidelines and are not a requirement. It's also important to note that some of the measures or items to look for within the verification checklist may not actually apply to the SERC sub-grantee or an agency.

The next few slides have been inserted to assist with talking through some basic items that should be checked for when you're conducting field verifications whether or not the checklists are actually used. There are some basic site-specific project information items that should be verified while you're in the field. The property address, a brief description of the installation type, the number of panels and the type of installation, just some background information on what has been installed is usually helpful for those documents.

It's important to note whether or not the modules have been permanently installed and also where they've been installed, providing a brief description and then giving that background information. You can see from these two photographs which are of the same system that this is a solar hot water system. It's an evacuated tube collector that's installed on a ground mounted system, so it's not included in the roofing system. One other point to note is that often photographs can give the field verifier some more information or remind them about the location and the type of installation after the verification has been completed.

The verifier will need to check components that are part of the solar hot water system besides just the panels. The back-up heater will need to be inspected and the type of fuel is important to note. Looking for basic installation criteria such as whether the quality

of installation is of a professional quality, if the installation matches any existing plumbing diagrams, and also it's really important to check for any city inspections.

One question that might help with the quality of the workmanship is asking whether you would be satisfied if this were installed in your own home. If there were wires and cords and piping and the installation was a mess, then the answer would probably be no and it's important just to make note of this and document it as you go along. The reason the city inspection is important to note is that it has been verified by the city for meeting mechanical codes and/or electrical codes.

Confirming aspects of the installation and that the equipment is new is important. Checking for labels and new components is really important in the visual inspection. Also, looking for solar rating and certification incorporation, ratings on the equipment itself is important. SRCC ratings to look for are OG100 for the collectors and OG300 for the system components, and OG300 will be found where there's domestic water load in a single residence. There are different ratings but these are the two to look for with most SERC installations.

Insulation that was disturbed during the system installation should be restored to the previous condition and penetrations should be sealed so that you're not getting any draft and air infiltration through the building shell. Checking that the pressure on the system does not exceed 80 pounds per square inch is really important. And then access to tanks is also good to note because the tanks should be easy to reach and clear of other items so that they can be maintained properly.

The image on the bottom shows an example of what the Solar Rating and Certification Corporation label will look like and there's also a link to their website in case you need to find more information about certifications or the ratings themselves. The images on the right show examples of what to look for with the image on the top being an overflow tank, the red tank is an overflow tank, and that's where you would check for the pressure. And the image on the bottom is just looking for new piping, new components within the system.

These photos show insulation that was repaired after the installation and the water tank is raised up off the floor and except for the box on the floor, most other storage items are kept clear of the tank itself for easy access and maintenance. The photo on the

right shows, again, the pressure gauge for incoming potable water and the temperature readings on the collector as well as the tank. So these are all good items to look for and verify after the installation.

Confirming that the collectors have been mounted adequately is essential. If the panels are mounted on the roof of the building, the roof should be in good condition and have at least ten years of life remaining, preferably more. The roof should be capable of handling the additional weight of the system and these two images are good examples of what you should look for. The example on the right shows an undulated roof with moss growing on top, indicating that there are some structural concerns. The roof on the right, just to show the contrast, would be a much better candidate for a system. If you see that the collectors have been mounted on the roof similar to the roof on the left, then this should be raised as a concern to improve the process of installation overall.

All roof penetration should be flashed and sealed to prevent moisture damage to the structure and it's also good practice to note whether there's any shading on the roof from nearby structures from vegetation. Obviously we wouldn't recommend cutting down trees to provide better solar access, but again, this could be used for improving siting of installations overall in the future.

It's good to check the plumbing during visual inspections and make sure that no plumbing is leaking. It's really important if you do see a leaking tank valve or any leaking pipes that you contact a plumber or the installer to fix any leaks afterwards. Pipes should also be copper or stainless steel, except where there's a potable (or a cooler) water source and these types can be PEX piping. Most connections that you see are going to be fitting with copper or brass. If you see PEX pipe coming off the water tank or the collector system and they're warm, it's important to raise this with the plumber or the installer just to make sure that this is not connected to the hot water supply.

Pipes should also be insulated, particularly in unheated basements. A lot of water tanks are going to be located in basements, which are typically unheated, and so to make sure that the hot water stays hot and reaches the areas of the house where it's needed, the pipes should be insulated.

This image shows the copper piping, what to look for in an installation and then the second image shows a thermal image of the pipes. Where you see red areas is where heat is coming off of

those pipes. Not that you would all have a thermal imaging camera, but this shows where that heat is coming off. If those pipes are insulated, you wouldn't see the red areas in the image.

These photos show pipe insulation which is probably installed fairly quickly and it's not covering the pipe elbows. It's best to have all parts of the pipe insulated; however this is better than no insulation. This is just an example of what insulation may look like on those pipes.

Water heaters and electrical supplies should be properly grounded and comply with all applicable codes. This can often be verified by checking for the city inspection label that I mentioned earlier. It's important to check that the fluids are appropriate for the system and this can be done by comparing manuals and documentation to any labels on maintenance logs or invoices received. You often are not going to see a bottle just sitting next to the system itself. It's usually a health and safety risk to leave these fluids just lying around. But if you do happen to be there when the installation is taking place, you might just note what the label on the bottle is to give you an idea of what kind of fluid has been used.

Documentation should be provided to the client so that the owner's manual, warranties, etc., are kept with the technologies that have been installed. This is one way to display documentation; however this leaves a lot of room for mishaps. The documents could fall off or they could go missing. What we would recommend is providing a client file with this type of information filed inside or creating a more permanent placeholder that's secure just to keep those documents from going amiss.

It's important to check for proper documentation and for contact information. In some of the SERC monitoring visits that we've done, we've noted that the installation has taken place but the clients don't know who to contact in case the installation stops working or there are problems with the technology. It's important to make sure that there is proper documentation and that the client knows who to contact.

It's also really important to make sure that the client knows a little bit about the technology. They should know basic operation of the system. They should be able to read things like the flow meter or the thermometer to know if there's a problem with the solar hot water system, and again, they should know who to contact in an emergency.

Just to summarize, the key points to remember are that the verification of the installation is really important and monitoring is one way to assist with the success of future installations. If you notice something that doesn't seem right, just ask questions and point things out to staff and installers in a tactful way. If you don't know what to look for, remember, you can always ask. This is a learning process and it's all part of furthering knowledge about these technologies.

You can always look for clues on containers, invoices, and warranties, if you're not sure what should be included in a system. Taking photographs to include in client files is often a really good way to express what the installation looks like and also document in a very clear way. A picture is worth a thousand words and it can help trigger memories or help you to ask questions along the way. The last point is to document as much as possible because this will help with a number of reviews and with the learning process and sharing what works well.

So with that, I'd like to conclude this presentation and hand it over to Amy to open up for questions and answers.

Amy Hollander: Thank you very much, Eliza, for that informative and interesting information on monitoring residential solar thermal hot water systems. For those of you who can stay with us, we have some excellent questions coming in from today's audience. Our first question is regarding the maintenance of the system and this person is asking, "When you're talking about maintaining a solar hot water heater system, what specifically do you mean by that?"

Eliza Hotchkiss: Basic maintenance of a solar hot water system includes keeping the collectors, whether they're mounted on the roof or on a ground-mounted system, clean, generally keeping them clear of snow or washing them off in the summer once will help to keep the efficiency and performance level high, depending on what kind of system it is. If it's gravity fed, you're going to have lower maintenance. If it does have pumps to feed the fluid through the system, then those might need to be checked on an annual basis just to make sure that they're operating at efficient levels. And then again, if you have a system with a vacation mode, making sure that those modes are programmed correctly will also assist.

Amy Hollander: So Eliza, would you recommend an inspection annually of the system or would once every two years be adequate?

Eliza Hotchkiss: NREL generally recommends that the system be inspected on an annual basis just to keep those efficiency levels high and the production levels high.

Amy Hollander: And what exactly might that cost a low-income client?

Eliza Hotchkiss: That is a very good question. A lot of these issues come back to how much it costs. Generally, the rule of thumb is that it's going to cost between $50.00 and $100.00 to come out and check a system on an annual basis and a lot of it depends on whether the installer is doing that maintenance or if you have asked the client to do some basic maintenance on their end.

Another component that I forgot to mention is that sometimes with glycol systems, the fluid levels will need to be topped off if there's a leak in the system. Generally, that won't be seen, but as these systems age, the chances that the fluid levels will need to be topped off increases over time. Leaks should be inspected and fixed if that is occurring.

Amy Hollander: And topping off fluids, is that something that you would train the resident to do?

Eliza Hotchkiss: Generally, we recommend that an installer or a trained professional do that top off.

Amy Hollander: Okay, thank you. Next question, "Should a residence rely 100 percent on a solar hot water system?"

Eliza Hotchkiss: The answer to that question is no. In the design phase, if you can remember back to the beginning of the presentation, I did mention that a solar hot water system isn't generally designed to meet 100 percent of a hot water load. The general rule of thumb is that a maximum of 70 -75 percent of the hot water load. So it's always important to have a backup system.

Amy Hollander: Thank you. "How long is the payback on a system in the Southwest?"

Eliza Hotchkiss: That is a very good question and I should have been prepared to answer questions about payback. It's really going to depend on the efficiency of the system and the local cost. One resource that might be helpful in calculating this is the DSIRE website, and that stands for the Database of State Incentives for Renewables and Efficiency, and it does include energy efficiency incentives, as well as renewables. So that's D-S-I-R-E and that will give you an

indication of what types of local incentives there are that could be applied. Now obviously there might limitations with SERC funding as to whether or not you can use additional incentives or grant funding, but on average, a system could cost as little as $2,500.00 and with the more high tech components and higher efficiency systems, they can go up to about 8,000.00 or more. So it really does vary on the location of the installation.

Amy Hollander: Thank you. And how long is this system supposed to last?

Eliza Hotchkiss: Systems generally last between 15 and 20 years. We have seen some systems that are older than that. There are components that will need to be replaced. It generally depends on whether or not you're maintaining the system on an annual basis. The collectors can obviously be damaged by falling tree limbs or this isn't very common, but every once in a while, the older systems might be impacted by large hail. So it really depends on how well kept the system is and obviously the better it's maintained, the longer it's going to last.

Amy Hollander: Thank you. And what length warranty should we require for the major components with a solar hot water heater system? And Eliza, I can actually help with this question a little bit.

Eliza Hotchkiss: Excellent.

Amy Hollander: Normally, it's a five year warranty on parts and when we wrote the RFP template for the SERC program, we suggested that the agencies request a warranty to include parts and labor for five years simply because there is no maintenance agreement that can be purchased under the SERC grant. Now whether or not that was required at the beginning of the installation or if the agency was able to secure that with vendors, I think that's gonna vary on a case-by-case basis. But many of the solar parts should last at least five years and hopefully that's in your RFP that you used to get vendors to bid on your system. So I guess that's how I would answer that one myself.

Eliza Hotchkiss: Yeah, that's a really good question and I think that 5 years should be the minimum, at least for system components. That might be able to increase for 10 or 15 years for the collectors themselves because they're stationary and they don't require moving parts. So their lifetime should be a little longer.

Amy Hollander: Excellent, thank you. We have another question from the audience. "What is your recommender collector angle for solar hot

water in Michigan in the lower peninsula? I was thinking it was about 60 degrees," is what the audience person participant says.

Eliza Hotchkiss: Generally, the rule of thumb for the tilt angle on the collectors is to match the angle of latitude and add 20 degrees of tilt. So here in Colorado, where the latitude is 45, the angle would be 65 degrees and obviously that's going to increase the farther north you go. And the reason for this is that you want to capture as much of the winter sun as possible if the system is being used year round.The sun's angle is lower on the horizon in the winter because the earth is tiltingand the sun is farther south, in the northern hemisphere. So it's important to make sure that that angle is higher to capture more of the sun's energy.

Obviously, if you're in an historic district and you can't have the angles as high, then it would be important to use some of the NREL resource tools, such as IMBY, which is a good example of something that could be used to figure out what that tilt angle could be because often in historic districts, as long as the panel is not visible or it's not obtrusive or dominating the property, then it will often pass local code or SHPO (State Historic Preservation Office) requirements.

Amy Hollander: And what's the name of that website?

Eliza Hotchkiss: The website is called IMBY. It sands for In My Backyard. Some of you might have heard of the concept of NIMBY, which is an environmental concept that people don't want certain structures in their backyard (Not In My Backyard), and this is just a play on that. We want to encourage people to use renewables and so In My Backyard is an example, I-M-B-Y.

Amy Hollander: So the website is I-M-B-Y?

Eliza Hotchkiss: Yes, that's correct. http://www.nrel.gov/eis/imby/

Eliza Hotchkiss: A lot of these resources will be posted on the website after today's presentation along with the presentation. So if you go to that website that will provided in an email to you, you can see the resources available.

Amy Hollander: Excellent, thank you. Can you give an example of a poor use for these products?

Eliza Hotchkiss: A poor use of solar hot water technologies is typically when there's little hot water demand. Often we'll recommend that these be used in organizations or large commercial applications if there is a prison or a swimming pool. Those are obviously going to have a large hot water demand. So if you're installing these panels on a single occupancy building that has just one person in it, then that probably is not a good example of where to use these.

Amy Hollander: Thank you. So when you say that they should be used in a household with large consumption of hot water use, would it make more sense than for a household size of five to ten and not a household size of two?

Eliza Hotchkiss: Yeah, it can be applied in a household where there are two people, but obviously it depends on how much hot water they're using. If they're running a dishwasher, if they're showering, running warm loads of laundry, then that's going to be a higher use of hot water. So obviously the payback is going to be more significant if you have more of a hot water demand than a lower hot water demand.

A good example of this or an analogy is you wouldn't put a solar PV panel on top of a building that didn't have electricity or didn't use electricity. So this is similar to that. You want to make sure there is a demand for that hot water that's being generated.

Amy Hollander: Thank you. Can solar hot water systems be designed for vacation mode?

Eliza Hotchkiss: Yes. There are advanced systems that can have various settings to allow times of use. This will usually be within the control settings or you'll have a panel that allows you to program when the system is not in use and basically what it does is just shuts off the pumping system and it doesn't allow the solar collectors to overheat the fluid so that you're not heating water, you're not running those pumps through the system when someone is on vacation for two weeks. If you are investing in an advanced system, this is a good system to have if people are going on vacation just because it's saving energy and it's saving wear and tear on those pumps and the system itself.

Amy Hollander: Now is there any danger of the system freezing in vacation mode?

Eliza Hotchkiss: If you're in an area where you're going to have freezing conditions, then you'll have a glycol system and that is basically like having an antifreeze going through the system. This obviously is using a heat exchanging system so that the heat that's taken from

the collector within the glycol fluid is transferring to the heat exchanger and it's moving that heat into that hot water. So it's not actually running glycol through your taps, which confuses people sometimes.

If you are in an area that does have freezing conditions, like Colorado or Michigan, you would want to make sure that you are using a glycol system and any of the certified installers will be able to recommend the best system for your area.

Amy Hollander: And it sounds like running the system in vacation mode would require quite a bit of client education at the installation of the system.

Eliza Hotchkiss: That's right. The vacation mode systems or the advanced systems are going to require more client education, so it's important to make sure that the client knows how to operate that system.

Amy Hollander: So the checklist that you referred to in the webinar, are they required by DOE or for all SERC sub-grantees?

Eliza Hotchkiss: Yeah, the checklists that have been created for use by SERC sub-grantees are not a requirement. They basically were created because a lot of these SERC technologies are new technologies or newer to agencies that are installing them and so they're not necessarily familiar with what types of components to be checking for or verifying. They're basically just a guidance document that provides a roadmap for agencies and helps them to know what to look for but it's not a requirement by DOE.

Amy Hollander: Thank you. I have a question from the audience. "What is the maximum pressure for the fluid line?"

Eliza Hotchkiss: The pressure within the solar hot water systems is really important to note and generally it's 80 pounds per square inch and you want to make sure that it's not going over that level because then you get into issues with the system overall.

Amy Hollander: And what should you do if you're a low-income client and you realize that the pressure has gone above 80psi? How should we educate the clients to tend to that?

Eliza Hotchkiss: That's a really good question, Amy. If the pressure is going over 80psi, oftentimes there's a release valve and so what will be important to educate the clients to note is to watch that psi and if it is going over 80, to know how to use a release valve. A lot of

times, this will be in the documentation that goes along with the systems themselves but it's important just to give them a little bit of background information and to know what to do if that's going over that pressure.

Amy Hollander: And if the pressure continues to build and it's not noticed by the client or by the resident, what might happen to the system?

Eliza Hotchkiss: If the system has an automatic release valve, then what will happen is that the system will just stop working. And so the client will often notice that it's gone over that pressure because it isn't working and they're not getting hot water. It's important to make sure that this doesn't happen though because that obviously requires somebody coming out and looking at the system and can just increase the maintenance and repair cost of the system.

Amy Hollander: So it seems that it would be best to have a system with an automatic release valve and if not, make sure that the clients understand to check the system to make sure it's working and if it's not, it might be the pressure being about 80psi.

Eliza Hotchkiss: Right, and most systems do come with automatic release valves but this is where we were talking about the customized systems. The custom designed systems may or may not have that, so we do recommend that you use the engineered package or prepackaged system.

Amy Hollander: Great. Another question from the audience. "Do you have to replace the solar collectors very often?" And a follow-up question I would ask is under what conditions would you have to replace them?

Eliza Hotchkiss: So again, the collector replacement is going to depend on the condition and how well maintained they are. If they don't have cracks in them, if the evacuated tubes are still in good condition they're still going to be operational. So we generally see that these panels are lasting 10, 15, sometimes more than 20 years, but that's something to note. Obviously there should be some client education. For example, you don't want teenagers or children going by and throwing rocks at these systems because that's going to reduce the effectiveness of them. So just making sure that they're well cared for is going to make sure that they're around a lot longer.

Amy Hollander: And a follow-up question to that is coming from the audience. "Can solar hot water panels be mounted on the ground?"

Eliza Hotchkiss: They can be mounted on the ground. If we go back to one of the images at the very beginning of the presentation, it showed that these panels have a stand. It was a wooden stand or a frame that they're mounted on. So they don't have to be mounted on the roof but something to note with that is that you want to make sure that they are located in an area that is safe and isn't going to encourage vandalism.

Amy Hollander: And what about putting a fence around certain systems? Is the cost of a fence going to make the system not cost effective? I mean I understand it depends what type of fence and how large of a fence, but I recall one situation where they couldn't – the roof was in poor condition so they elected to put it on the ground, but then they had to pay for a fence. So the question was do you pay for the fence or do you pay to repair the roof? And they were near a high school so they felt like they needed to fence it in since there might be a little mischievous behavior going on next door. So I understand you're probably not a fence expert and the cost of fencing, but is it important to put up a fence if you're in a low-risk area?

Eliza Hotchkiss: If you're in a low-risk area, chances are it's not that essential. Obviously it does vary on a case-by-case basis. So if you are next to a high school, it would be probably a good consideration. I know that the Department of Defense has put in some installations of solar hot water technologies and they have just put a fence up around the ground mounted systems, just to protect them from passersby. So it does depend if they're in a high visibility or high risk area. You just don't want to encourage vandalism because the payback may be in protecting the panels themselves and if they're in a better condition, then they're going to last longer, which helps your payback, as well.

Amy Hollander: And then of course it matters how good a fence climber they are, right? Okay, thank you. Is snow build up a problem for hot water heat panels?

Eliza Hotchkiss: Snow can be a problem for solar hot water panels, so it's important just to go out with a broom and make sure that the snow is swept off. Obviously if it's on a roof, that may be a little more difficult to achieve, but if there is snow, then as you can imagine, that will cut down on the winter production of the panel.

Amy Hollander: And then if it's not safe to go on the roof and brush the snow off or perhaps the resident is not physically capable, might that be a reason to mount the system on the ground?

Eliza Hotchkiss: Yes. That could be a really good reason to mount it on the ground.

Amy Hollander: If they have the yard space, I guess. Okay, one more question which I think you mentioned, but can backup water heaters be gas or electric?

Eliza Hotchkiss: They can be gas or electric. The fuel type that goes along with backup water heaters is basically the same for any water heater that is conventional. So you can use a solar hot water system to top up a water tank and then use a gas or electric system just as a backup.

Amy Hollander: And so when you order the equipment for the house, whoever's doing the analysis would try to incorporate the existing hot water heater, whether it be gas or electric?

Eliza Hotchkiss: Yes, that should be part of the system design. If you have a certified installer, they should know what to be looking for and whether or not you should be using gas or electric, because obviously it depends on the availability of fuel sources and the type of dwelling.

Amy Hollander: Okay, thank you. That concludes all of our questions from the audience. Eliza, do you have any closing thoughts or comments for today's audience?

Eliza Hotchkiss: The only thing I'll mention is that this webinar will be posted on the website. You will be sent some more information about that and we will include some resources that will help you with calculating payback and finding out what the solar resources are for your specific location.

Amy Hollander: And another thing we can do is we can email all of today's participants with the latest checklist for solar hot water and then you'll have that at your fingertips, as well.

So thank you, Eliza. That concludes – just to see if there are any more questions. There are not, so that concludes our question and answer session and for those of you who missed the beginning, I'll mention again that you will receive a link to the webinar via your email box but it will not be posted for ten days to two weeks, so please keep that link in a handy place and you can access the webinar that way. With that, we will sign off and wish you the

best in your workday endeavors. Thank you very much for joining today and goodbye.

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