Sustainable Energy Resources for Consumers Webinar on Residential Water Heaters

The following is a transcript of a Webinar recording about efficient residential water heater technology. The Webinar was presented on Feb. 22, 2011, for Sustainable Energy Resources for Consumers Grantees and sponsored by the U.S.Department of Energy. Watch the video recording.

Moderator: Thank you for standing by. I would like to remind you that today's call is being recorded. If you have any objections you may disconnect at this time. Also momentarily your lines will be placed on a listen only mode for the conference and answer session. I would now like to turn the conference over to Amy Hollander. You may begin.

Amy Hollander: Good afternoon, everybody. My name's Amy Hollander, and I work with NREL with technical assistance for the SERC grants, and I want to welcome everybody to today's webinar series. I want to thank DOE for sponsoring this webinar series. Today we have Jerome Galiano who is going to review high efficient hot water heaters for us. I just wanted to mention a few upcoming webinars. Actually we only have one scheduled for March 8, and this webinar is going to be on home energy monitors coupled with another topic that we have not selected yet. If there are specific webinars that you would like to see us conduct, please feel free to e-mail the circumstance e-mail box for all of your requests whether they be for webinars or additional technical assistance, and that e-mail address is SERC_TA@NREL.gov and again our next webinar will be March 8 same time same place, Tuesday at 2:00 eastern standard time. So for today I would like to introduce Jerome Galiano.

He has extensive building performance experience including home performance energy audits and ASHRAE level two and three audits on commercial and multifamily buildings. He is a frequent presenter in national conferences including the green build, the ACI, the ACEEE, and has served on technical panels such as DOE's national evaluation and the DOE clean energy road show. In addition to delivering auditor accreditation and energy modeling software training, Jerome provided technical consulting services on

a three-year-long evaluation of green multifamily housing. As a strong proponent of visualizing cost-effective techniques for energy audits, he considers building measure fits as a financial and societal investment from start to finish. Jerome has a BS in mechanical engineering and a masters in material science and engineering from Virginia Polytech Institute and State University. He's a licensed professional engineer, a lead accredited professional, and serves as chair of the multifamily homes group for efficiency first. So Jerome, thank you very much for presenting today. I wanted to also let you know that Tyler Huebner is on the line to help answer programmatic questions that may come up throughout the webinar. With that we will get started with today's webinar. Thank you, Jerome.

Jerome Galiano: Thank you for the introduction. It was a long introduction. Today's topic is residential water heaters and the focus is gonna be on the higher efficiency models but I will be including all the different types of technologies. The conventional ones you've seen already in the field and that are still being sold out there just so we can spare and contrast really what the differences are between a conventional water heater and some of these newer more efficient water heaters. The overview is gonna be taking us through all different technology options. Again, everything from the conventional to the more efficient ones. For each type of technology, I'm gonna go over and highlight what makes this type unique. How does it operate, then go to some considerations and issues and options for that technology. Then go to the next one, same thing. Do an overview of technology, considerations, and options. Then near the end we'll go through how do we choose the right one depending upon what's already in the house, what region you're in, other considerations from space requirements may lend and direct us to one option over another.

Then we'll talk about some other resources or looking up ENERGY STAR criteria for instance and how do you know what are the criteria in order to make sure that the water heater technology you're looking at does meet that criteria and looking at how that criteria can be used or RFPs if that's what your organization is putting out at times to get a bunch of water heaters installed. Then we'll wrap up with questions from you all. I've put

them into groups that I think make sense where what you physically see in the field and how they're performing. The first group we're gonna talk about is storage water heaters. While there's different ways of heating the water, they really rely on the water's being stored and being heated by some direct element in the water heater. This is conventional. It's the typical water heater you some across in many homes. These are on your audits. The newer technology of condensing water heaters, condensing gas water heaters then heat pump water heaters. Same idea as your heat pump heating system down south. That same technology being put into a water heater. Then instantaneous water heaters. These don't have storage tanks and look at conventional type. They use gas, propane or electric as well as some newer ones that only a few companies are making that's a condensing instantaneous water heater. Then we'll go into indirect water heaters, the combination of boilers and storage tanks or just the boiler alone heating water and lastly solar water heating systems.

So conventional water heaters here's three examples. I think the oil-fired one. It's oil fired, 20, 30. Here's the burner. In this case the tank looks the same and pretty much is a similar inners in these tanks. The flue here, your oil burner, gas thermostat and gas regular laying valve. The burners underneath combustion air coming in. Again, a flue up here. Electric, you have electric element at the top and bottom. Each case the tank looks about the same. Just a little bit different technology of heating them. For some of you this might be a review but just to make sure we're all on the same page. Some of the key pieces of a water heater, source water heater upper and lower thermostat and elements are in electric water heaters and each one of these water heaters is typically gonna have an anticorrosion anodes. That's what protecting the tank a lot of times. These things can a lot of times be replaced and a new one can be put in. Basically it corrodes before the tank should. It's there to be a sacrificial device to try to protect the tank. Cold water is filling up at the bottom of the tank. Hot water at the top of the tank. All tanks should have a pressure and release dial and a proper downspout that meets code. These should never be covered over. The side of the tank should never be covered other than by an insulation jacket. Don't try to test

them because once you try testing once, they will not usually shut off.

Gas version of this, the burner's at the bottom. The flue pipe is going through the water heater or through the storage tank. Heating the storage tank through that method versus having to use electric elements. I believe you can see my mouse moving around. So again the fuels here from a gas propane, oil, or electricity and the way these work is they're trying to maintain the water heaters know nothing about the draw coming from the showers being used. They're only trying to maintain a set point for the thermostat that's trying to keep the water temperature set to 120, 130, 110 depending upon what the thermostat's set to. Electric water heaters sometimes it's two elements which is nice where usually the lower elements is usually set to meet the water temperature of the tank at 120 and this one, the upper one is set a little bit lower and that way when there's a large draw, a lot more cold water coming in to cool the tank off, the second element will kick in and help meet that draw from the house. Some options on conventional let's say conventional, or even the newer water heaters is conventional's have a venting that typically comes off the top and it's going into the chimney.

Some of the other water heaters that's still a conventional gas water heater but is a little bit higher efficiency do sometimes do a better flue and heat exchange but also what's called a direct went where we can get rid of the need for the chimney and vent it directly out to the side wall. So some considerations of this, they're simple when you replace any kind of water, this is typically what you're gonna find in a house and so if you're gonna install a higher efficient version of a storage direct fired water heat, the it's only a plug and play. Typically there's not a lot of new plumbing or electric or gas line modifications needed. This is the technology that probably could be installed by the weatherization crews again, depending upon what code is specified in that area and if they require a licensed plumber or electrician to touch any of this but the other thing is normal maintenance plumbers understand them. If they fail at night, someone can usually replace it or fix it. They do need a catch pain and a drain for leaks and a pressure and leak valve should be able to be free and clear and there are possible

remote locations. Old school versions of these don't have -- they might have a pilot that may have a spark ignition. Most of the ones now they can spark ignition but then you need electric power that could be seen as an advantage of a pilot even though it's using more fuel if possibly in a remote location where power outages are common. So the next type of storage water heaters is the condensing storage water heaters. One brand -- there's only a couple manufacturers out there right now. I'm sure more and more will be coming online. It's essentially the same thing depending on the brand. In this case the combustion air coming in the top.

Exhaust is coming out the bottom and there's a condensate line for removing the condensate from it condensing. What's going on here is that we're actually going to condense the flue gas. So in a typical hot water heater, typical hot water heater, we had our flue gases going right out the top. The flue if you remember was just one straight shot. Well, here the idea is taking the flue and making it really, really long to increase the surface area, exchange more heat and exchange enough heat off the flue gases until they actually condense and a lot of heat's given off in that condensation process. A lot of heat is given off. More heat's beening absorbed through the water then. We hot higher efficiency. The by-product is still combusting gases, but they're much cooler and condensates. The condensates have to be removed in some way. That doesn't mean considering you might have a condensate drain nearby for this type of technology. Again, it's similar to the conventional water heaters where it meets demand by storing capacity. It doesn't know anything about the drawl from the house. It's just typically trying to maintain a temperature that's in the side of the tank on the thermostat. The difference is that it has a much larger gas input than a conventional water heater. The ones that have been made so far have a larger capacity. It's able to meet higher demands and recover quicker. In other words the recovery meaning that as cold water's added from hot water being drawn off the tank. They can try to maintain a set point temperature faster. A lot of these have been sized for large drawls at least the few that I've come across in the several makers out there. One concern can be if this is application is not used in a proper -- the supplies aren't used in a proper application, for instance if you're placing a conventional water heater in a household of one or two people who

don't use a lot of hot water, with this new water heater, there's a much larger gas input. For instance something like in the order of forty thousand Btus typical conventional gas water heater and these are somewhere around one hundred thousand Btus gas input.

They can cause short cycling just the same idea of boilers or furnaces that short cycle when they're oversized for heat load. This larger gas input, you may need to up size the gas tray which means you may have to replace the gas line. Taking that into consideration, the cost of it may be -- inflation cost can sometimes be as much as the tank itself depending upon what modifications are needed in that space in order to accommodate this new hot water heater. One big advantage is the venting and the combustion air and venting can go through PVC and the venting can be PVC because it can combust the combustion gas temperature much lower just like you're condensing furnaces or boilers. This means simpler and less expensive material for the venting. Because they're such a new technology, we don't know how long they will last. Probably need a specialized technician or someone who's the manufacturer's rep or someone who knows exactly how these systems work and how they can be served and how often they give you service. Most likely you'll need service more often than your conventional water heater. The last type of storage water heater is a heat pump. The heat pump water heater works similar to that of a heat pump that's heating and cooling your house. Basically like a refrigerator running in reverse. Here's an example of a new water heater. They also make these little retrofit kits that can be added on top of the conventional electric water heater. The pieces of this are again, you have your storage tank but in this case the evaporator and the condenser, the condenser's usually the outside unit and the split-system evaporator is usually your coil that's providing your cooling and your furnace. Same pieces. They're just in a different configuration. Compressor, condenser, evaporator, and typically they're gonna have some kind of back up heating element. In this case it's gonna be electric resistance heating element. The reason we can get much higher efficiencies out of these, they're still using electricity, but we're moving heat.

We're not actually -- unless the electric resistance element comes onto meet or satisfy capacity when the heat pump can't, you're

moving heat from the environment into the tank. This case here's one example where the condensers inside the tank. Here's another example schematic where the condensing coil is actually wrapping around the tank here. These little red rectangles if you can imagine it's the coil wrapping around the tank and delivering heat to the tank through that means. Again, similar components for these conventional water heaters. Get a sacrificial anode. Water in, water out. There's some kind of heat source. Excuse me. Some considerations when looking at possibly installing one of these water heaters. One is that it should be installed in a space that can be maintained from 40 to 90-degrees year round. There should be about a thousand cubic feet of air space. It cools off air where these things are actually gonna generate cool air. They're gonna reject the cool air into the room whereas your refrigerator rejects warm air into the room. These reject cool air into the room. For a heating-dominating climate for instance, you don't want these rejecting cool air into your condition living space. Probably install these in an unconditioned basement. The converse is true for a cooling-dominated climate. This is additional free cooling if you will that can go to cooling your living space. There's a good research paper by DOE of field testing of proto-tech residential hot water heaters. They make a bunch of these heat pump hot water heaters and throughout the country of different sizes and put a different space of some in the living space, some in the basement. They found the COP, the efficiency didn't really correlate to one or the other. The found the COP sort of ranged from about 1.5 to about 2.4 for COP. COP of one being 100 percent efficient. COP of 2.4 being 240 percent efficient. It's a really good paper out there from DOE. Last we have instantaneous water heaters, and these take quite a few different forms because of the type of fuel being burned. Then the different technologies. The gas or propane fired water heaters, typically they're directly vented, sometimes it's concentric vent, sometimes it's strong combustion air for the room and exhausting directly outside.

Newer technologies whether it's condensing, gas fired, instantaneous water heater, and it's in this case this product is seal combustion bringing the combustion air from the outside and exhaust air to the outside. Electric water heaters similar idea to electric element heating instead of gas but because electric is more

available throughout the house, you can have point of source type instantaneous water heaters versus a central water heater. So central water heater in a point of source like underneath the kitchen sink or directly for the shower or just for the washing machine for instance. How these work for gas is similar. We have a heat exchanger. Cold water comes in and gets heated up and hot water goes out. There's no storage so very minimal off cycle. In other words when the main shuts off, there's not a whole lot of losses coming off this because there's not a lot of storage, not a lot of storage water here. The advantage is you're heating water only as needed. One of the considerations is the thing to understand is it takes a little bit of time for the heat exchanger to heat up so as the faucet comes on, water's being dropped into the system. There's a flow center that detects water flowing through, that tells the burner to fire up.

If you know from doing any type of combustion, it takes a minute or it takes a little while before your heat exchanger comes to a steady space. So during that period, someone can be drawing hot water and they might feel cold water possibly for a longer time than they would on a conventional tank. There are some manufacturers out there who will put in a little small bumper tank. Might hold a gallon or less of water that stays hot and that way people get the hot water even quicker while the heat exchange is heating up. This is a diagram of a condensing gas instantaneous hot water heater. In this case it has two heat exchangers where as that condensing storage water heater is one long flue pipe. In this case, to save space as a secondary heat exchanger, one heat exchanger is meant for taking initial -- extracting initial sensible energy off. Secondary heat exchanger extracts the latent energy off. Again, you get cooler flue gases. You get the condensate out of the pipes, and there's gonna be some kind of condensate line needed. You're gonna have to deal with that condensate coming out and take that to a drain and meet code. A lot of time condensate can have corrosive by-products in it that need to be disposed of or filtered through before just dumping to a drain. Some of these hot water heaters also gonna have a recirculation system in them. It's another way of saving a lot of warm water from being just dumped down the drain. When the hot water comes it just saves that cold incoming water from being dumped.

Recirc systems are really nice especially when it's integrated ready for the product but the house has to be set up for that. Recirculation is probably gonna be more in a rehab or a new construction. Simple schematic of the electric water heater. It's just like the little device you're heating up a cup of hot water in for your tea.

Electric resistance element that is copper, that's just electric resistance coil like you use for heating your food at home. That's heating up the hot water. Condensing options. They can come in all different types. Seal combustion just means you're taking your air -- combustion air from the outside and flue gases go to the outside. As in this case, it doesn't necessarily mean this product is a condensing instantaneous water heater. It may not be. In this case, this one's not actually instantaneous. It's just a one heat exchanger instantaneous water heater. These field combustion vents can also be done where as a concentric vent whereas the concentric vent be intake air is being preheated by the outside air which actually increases the efficiency of combustion. Direct vent typically just refers to the combustion air being drawn from the room and being exhausted through one pipe. Typically again not through a chimney but usually through the side wall. It's not condensing it's gonna meet local code for preventing typically some type of de-vent able to protect against the high temperatures. Ignition. They come in all different types. The cheapest model is gonna have a pilot ignition. So there's a pilot burning all yearlong. There's a sparking ignition that's gonna require electrical power. There's also sparking ignition that also sparks from a power wheel. There's actually no electric power required. The paddle wheel turns and can be turned by the flow of water being drawn through the system. That actually creates a spark to ignite the flame. Some considerations. Definitely some major advantages. Small profile. Saving space. Quote unquote endless supply of hot water once it becomes hot. One consideration and design for that house, you're looking at retrofitting is to put an essential hot water system or to have point of view hot water.

That might depend upon location. If the only place to put in the central hot water system in order to vent the flue gases is say fifty feet or something really ridiculous from where the water is gonna

be used and it's going through a crawl space, consider that maybe a point of view source might be better. However, using electricity which typically will be a more expensive source than energy. Those are some things to really consider. There's more design involved in using this type of system. The piping. If there's a chance for re-piping the system to minimize pipe length. The size of the system really depends upon the usage demand of the house and the cold water temperature. There's no storage buffer in these or a large storage buffer. Cold water temperature in our country can vary from 40 to 70-degrees and this can greatly reduce the number of fixtures that can be run at the same time in the house. For instance to maintain 105-degree temperature at a faucet is one model or the same model could possibly provide hot water to say one shower and a faucet in the far north where it might serve as many as three shower heads and a faucet in the far south just because entering cold water temperature. Some people like them because they provide clean, quote unquote clean hot water. There's no rust or build up of scale in the tank. They typically last a lot longer and require less maintenance than traditional tank because there's no tank that there to corrode. Most source tanks will corrode over time. There's a much larger gas input just like that condensing storage water heater. You may up size the gas train in order to -- if you're replacing conventional 40,000 Btu input water heater with an instantaneous water heater. It needs a much larger -- it needs to have a much larger Btu capacity because it has to heat -- think about it heating up this water as it's slowing by.

It's a very large heat exchanger. It needs enough gas capacity to do that. The condensing instantaneous water heaters. It's a new technology. It's fairly complex. You definitely would need a specialized technician for servicing and troubleshooting problems with these water heaters and the installation of it possibly -- it could be installed by whether this included the condensing one. It's possible as well the manufacturer spec are very, very tightly written and they'll void the warranty if you don't install them exactly how they specify. Now onto indirect water heaters. As the name describes the water is not being heated by an element that exists directly within the tank. In this case over here is our storage tank. Over here's our heating elements, and we have piping

running in between and pumps moving the hot water. So restoring the water in the tank and it's being heated by another device that's not part of the tank. You wouldn't install one of these just to heat hot water, but the advantage of this is when you already have hydronic heat in the house, that you take advantage of that one combustion pilot. Especially if it's already a high efficiency or fairly new boiler or possibly if you're replacing an old boiler and the storage hot water heater needs to be replaced as well, replace both of them with say a new condensing mod con boiler and a indirect storage tank. These do require a lot of design and proper design. Plenty of them go in without proper design, but if you want to maximize the efficiency of how these operate, they really need to be designed well and piped in correctly. So our schematic here, our conventional atmosphere boiler, our pump moving boiler water to the storage tank.

Not mixing water, but you have a heat exchanger here dropping heat into the tank. Not mixing water but you have a heat exchanger here dropping heat storage tank, taking the cooler water back to the boiler to be heated up again. It should be well engineered, the design, if you really want to maximize the efficiency of the boiler providing heat to the tank. The circulation has to be designed so that the circulation pump stops running when the tank reaches the set point. I've come across many seals where the tank -- the pump is running all the time. What that means is what the tank is hot and the boiler stops firing. The heat exchanger exchanges heat in both directions. It doesn't care which way it happens so it's gonna keep pushing water through this boiler so there's a large heat exchange in the boiler and there's air flowing through that exhaust flue so you can actually start robbing heat back out of the tank and go right up the flue. So proper design has to really be done. This should be done by a qualified contactor. Two different options for the heat exchanger. One is the heat exchanger being inside the tank like the schematic we just saw and this down here. The other heat exchanger is probably a plate and frame heat exchanger.

These types are nice if you already -- possibly already had a storage tank, maybe a electric storage tank or a good storage tank is already running or in good shape and has got many years left on

it. Heat exchanger is placed outside of the storage tank. It might be down here for instance having a little heat exchanger right here. There are a couple options that allow you to utilize different types of storage tanks. One big advantage is you're limiting having two combustion appliances. That's less maintenance, less losses up the flue stack. The unfired source tank will last longer than direct-fire tanks just by virtue of they're not being heated from underneath and a lot of times they also have higher insulation values on them. Again, they're very complex designs requiring engineering and should really be installed by a qualified plumber. Typically get a fast response and greater hot water output than conventional direct fire source tanks. Mostly because you have a large boiler that's providing the heat. Last technology is solar hot water heaters. Solar hot water heaters -- they are a technology that exists by themselves. Think of it more of a preheating system. So the part of the water heater technology is the collector. There are two different types of collectors. You have evacuated tubes, we have flat-plate collectors and in certain climates, the evacuator tubes are better for it. They just perform better depending upon outside temperature in an amount of sunlight than the flat plate. Sometimes the flat plate performs just as well as the evacuated tubes for certain climates but cost a lot less. This example here there's actually a storage unit that's integrated into the collectors thereby limiting the need for having a secondary storage tank in a house sometimes. Here's a schematic of a complete hot water heating system. Our collectors, there's pumps circulating water between the collectors and some kind of storage tank.

Again, a storage tank might exist up here as part of that collector or it's down inside the house. Then this water is -- there's a couple different scenarios but this water's been heated either directly or indirectly by some other means. Either there is a secondary conventional electric or gas fired hot water heater and on demand hot water heater or possibly in this case, this is running to and from the boiler system. You can have your heating boiler providing additional heat to heat the water the rest of the way because the systems only are gonna provide hot enough water when there's sufficient enough sunlight. There needs to be a back up source for this type of technology. If you get another schematic, sometimes you can actually have both heat exchangers integrated into one

storage tank which is really nice. Less space and just a simpler, simpler for piping and there's less engineering involved. We have the heat exchanger coming from the solar collector and then the secondary heat exchanger that's coming from the boiler back up or from an on-demand hot water heater for instance. So be aware there are quite a few different types or options in these solar hot water heating systems. Direct verse indirect circulation of the water. Direct systems means that the hot water that actually -- it's a pot of hot water is actually being circulated through the collectors on the roof. These aren't as common because at least in colder climates, a lot of newer systems tend to be indirect circulation so some kind of antifreeze solution is being circulated through the collectors collecting heat then through heat exchangers dumping that heat into your water. Active versus passive solar. Active meaning using pumps and electricity. Passive would be just a thermal siphoning of the heat from the sun. Drawing water through the system.

Passive is nice because it's less electricity being used but it's much trickier in design and it's not as reliable of a source for getting that hot water. Again, flat plate or evacuate tube collectors and then what's the supplementary or auxiliary heat source. Like I said that could be anything from the hot water heater that's already there. You might have two hot water heater tanks. The hot water heater from the solar and a conventional hot water heater. Maybe you have the storage tank plus a con demand hot water heater. These can be designed to cover up to 90 percent of the hot water load so that's a lot and again, think about it. You have to spend to save so if your hot water load is really large in a house or especially in these multifamily complexes, the more you spend the more possibility of savings. So if the hot water is large enough in the house, it may warrant -- it's saving more units of energy, saving more dollars. Reducing pollution is another benefit of this type of renewable energy. Systems do require a lot of routine maintenance. A lot of different parts, a lot of pumps going on. If we come back to the schematic, there are as many as three different pump sensors. There are valves. A lot of components to the system that really need to be checked on to make sure things are operating correctly. Just like the other example of indirect hot

water heaters. The pumps not operating properly, you can actually strip heat out of your system and reject it to the wrong place.

Again it requires engineering design and should be installed by qualified technician and for servicing. Because these collectors can really collect a lot of heat especially as they're storing heat into a hot water tank, if no one's drawing hot water for several hours on a sunny day, the temperatures in these tanks can get up to 180-degrees, so you need a mixing valve or tempering valve off that storage tank to prevent scalding. The last bit here we want to talk about it is how do we decide on which technology is the appropriate one for the house or the building that we are looking at retrofitting. Some selection criteria. Really the fuel type and availability if you have a house that doesn't have gas, well that narrows your choices down to high efficiency electric storage, heat pump technology, or the instantaneous electric hot water heaters. That's a big impact if you have two different fuel types available. You can do a cost benefit analysis of which one. Giving you efficiency in the cost of the fuel as well will produce the higher amount of savings. You need to know the hot water demand of the house. The property size of any of these technologies. Most of the time a conventional 40 or 50-gallon storage tank can handle most houses. But really if you're gonna retrofit the situation, know what the demand is. How many people? What kind of water draws? How many showers are they taking each day? Again, it's energy efficiency. Try to maximize the -- your energy, savings, and costs. Not only for the technology, but think about reducing -- as part of any holistic approach, reducing the water draw first with aerators and pipe insulation things like that before putting an oversized system. Same concept is when you're installing your furnaces and boilers so you're gonna install a proper and smaller-sized hot water heater. Installation cost really needs to perform a financial analysis to determine which option is most cost effective over the expected lifetime.

There's a couple charts that I found that have taken some of the sort of range of savings and costs. Really each one of these depends upon the scenario of the house. Depend upon the cost of fuel in the house. The financial analysis should be done to determine what is the life cycle savings to really decide which

technology you should go for. As you see here, high efficiency storage. Demand using gas, electric, heat pump type, or solar in this case with electric back up. The range of savings heat pump and solar saying mild to hot climates. The DOE paper found that there are lots of excessive heat pumps in climates that aren't as hot. You're probably gonna get better results when you are rejecting cooling into this space in a cooling-dominated climate. You're gonna get additional benefits, but the heat pump hot water heaters are still being used and tried out through out the country. Again, you have to consider what space you're putting them in. Ranges of cost here. In some cases, electric on demand hot water heater can be as cheap as three, four hundred dollars. Some of these costs if you consider the -- I'm sorry. The savings. The cost is on a different slide I have. The savings can range all over the place and really this is just giving us a general idea. The big picture to look at is the lifetime of these technologies. Direct fire. There's no storage tank. Even indirect storage tank typically will last as long or longer as the boiler. Solar back up again because we're not dealing with a direct fire storage tank. How we doing on time? This with a comparison from ACEEE, they put together different technologies we talked about today. Here's some energy factors with the number we're used to looking at and using in our energy analyses with heat pumps and solar energy factors greater than one or greater than 100 percent if you think about it in those terms.

Then looking at the total cost of the annual energy cost this year. What it cost to run that appliance for this given house. For this given cost per therm and gallon and electricity as well as the install cost. So conventional oil-fired hot water heater costing the most, the least being down here with the electric heat pump, hot water heater, gas. Solar hot water heater and electric back up has more expensive upfront costs. The annual costs are much less. It's not -- it somewhere in the range of these high efficient electric storage water heaters. Again the comparison really should be done specific to that house. Quickly some overall strategies from ENERGY STAR. Consider entered pipe as the gas storage. You don't want -- you want a short of installation routine maintenance. You can expect about a 7 percent savings. Whole home gas tankless or instantaneous which is another word for tankless or on demand is another word for that. People are complaining about

running out of hot water. Have a limited space. Possibly install it in a small closet. You want the water heater to last longer. The installation maybe a little more complicated. Again, you might have to up size the gas line but could see as much as 30 percent savings. Gas condensing water heaters again, running out of water often is a problem for the residents. In these cases we might see as much as 30 percent savings from condensing gas water heaters. Heat pump water heaters might see as much as 50 percent savings over conventional electric water heater. Again there's that additional benefit of being a cooler dominated climate of rejecting cool air to the environment.

To really consider your intake source. Some of these heat pump water heaters are also combination heating and cooling systems and they actually will reject heat outside in the wintertime -- or sorry. Reject the cooling on the outside in the wintertime and reject the cooling on the inside during the summertime. Solar, if your location has deficient sunlight, you want to go for a maximizing savings. This has to be the kind of homeowner -- it's the typical homeowner who's really into being meticulous about maintaining their house. If they see the maintenance of their house and the way they take care of things and they are willing to take on this additional task of regular maintenance and schedule that kind of maintenance, that could be a good option for them. Tax credit from ENERGY STAR. The criteria's laid out on the web site at the end of this presentation. They lay out here what the requirements are for efficiencies. For instance gas condensing with energy factor greater than .8 whereas a typical or sorry a gas storage water heater having a energy factor greater than .62. When you're thinking about creating RFPs to put out a bid for someone to install a bunch of water heaters, I would say make sure you specify the equipment needs or meets ENERGY STAR criteria. Design for indirect and solar water heaters should be stamped by an engineer.

That could be a large cost. Shoot for that and you might have to compromise but those systems can go in many, many different ways even after it's been designed correctly. A qualified installer being specified and a really good engineer design. The contactor should dispose of the replaced water heater unit in compliance with

EPA guidelines. Try to have apples to apples comparison. Make sure your bid proposals don't include rebates or tax credits. Have those caught off separately if you're gonna show you what kind of cost each one is gonna be. Make sure you have certified and licensed contactors and that combustion venting meets all local criteria. Probably even better. You should probably specify the -- call out as much as possible the kind of venting you want to have for these houses. In a lot of cases we can get rid of those some those serious problems of having to put liners in chimneys or fixing up chimneys and getting rid of some of those large air leakage by eliminating and venting the chimneys. Here are some web sites. Talk about ENERGY STAR. Energy Savers is a nice one to give you a general overview of technologies. AZEEE that's where I found that one comparison of the cost of savings. AHRI used to be _____. They combined. It's a great, great, directory. You can look up any residential or commercial equipment or appliances from water heaters to furnaces and heat pumps et cetera and you can find their actual certificate of their efficiency capacity by make and model. Here's one of the solar ratting links.

There's lots of other informing about solar hot water out there. Again, it started with a -- once you come to the conclusion of which technology makes the most sense, work with a contactor to determine what the proper size, what the proper technology can actually fit into that application. So thank you for your participation, and I'd like to open it up now for questions.

Amy Hollander: Thank you very much Jerome. Hi, this is Amy Hollander from NREL, and yes, I'm sorry I neglected earlier to explain that Jerome is from Performance Systems Development so he is a contactor for NREL and I also wanted to get the attention of the moderator. Wendy, are you there to unmute the phone?

Moderator: Amy, did you push star zero? Amy.

Amy Hollander: Hi, is this Wendy?

Moderator: It's Kami, do you hear me?

Amy Hollander: Yeah.

Moderator: You have to push star zero to get Wendy on the line.

Amy Hollander: Okay. I just did. Is Wendy the coordinator available? Okay, this is Amy Hollander. I pressed star zero Kami. Is there another option?

Moderator: Let me see. Hold on.

Jerome Galiano: Press star six.

Amy Hollander: Hello? Hello.

Tyler: Yes, hi. Tyler here.

Amy Hollander: Who else is on the line?

Tyler: Well, a number of people.

Amy Hollander: I'm still not able to get the moderator so old on. I'll try again.

Amy Hollander: Hi, Jerome. Are you still on the line?

Jerome Galiano: I'm still here.

Amy Hollander: Sorry. We're having some technical difficulties. We're attempting to un-mute the lines. Please feel free to type in your questions to the webinar. You can do that by accessing the menu option at the top of the screen. You can click on the Q and A button, and it should allow you to ask a question. Jerome, I have a question for you.

Jerome Galiano: Yeah.

Amy Hollander: With the tankless hot water heaters, I know that they're often used in Europe and that the users are somewhat accustomed to not using the appliances in their homes at once. This assist with the problem of not having an endless supply of hot water heater or having enough hot water. I wondered what you might do if you're selling an on-demand tankless hot water heater.

Jerome Galiano: So from you speaking everyone heard you speaking or was that just to me? Do I need to repeat the question?

Tyler: Jerome, this is Tyler. I think everyone should have heard the question.

Jerome Galiano: Okay. What I say requires.

Amy Hollander: Now all the lines are open. If the audience could please mute their phones if you're not speaking so we can --

Jerome Galiano: To answer the question about what kind of homeowner education would be needed if you replace conventional hot water storage tank on demand also called instantaneous water heater. Yeah, I think it would behoove them to let them know -- giving the input water temperature and knowing that the size you selected for that house to tell them look is this thing can provide -- you don't need to tell that specific of details but if you know it can only provide five gallons of hot water per minute at the right temperature so entering 50-degrees it can do 70-degree rise get to 120 or whatever. You have to figure that math out but you can come up with that number and say okay. Typically this isn't gonna put out at most 5-gallons per minute so homeowners, the shower head and the faucet head you really shouldn't use two showers at once or two showers and one faucet. I think if you put it in those kind of terms giving them quantities, it's pretty easy to remember. They don't need to know gallons per minute and all the specifics. You can put it in terms of number of fixtures at the same time. That would probably help them to understand how to use it.

Amy Hollander: Thank you. Tyler I have another question that's mostly for you regarding any rebates that might come along with hot water heaters. Are these to be figured in to be SIR?

Tyler: Whoever's on the phone if you could mute, that would help a lot.

Tyler: As far as rebates go, it would be handled the same way as they're handled in the lap program for any of those agencies that currently work for utilities and rebates.

Amy Hollander: Then is this rebate -- what happens with the rebate with the WIP program?

Tyler: I actually don't know how those programs work. The local agencies will understand how they work. As far as calculating SIRs, you recall -- for these measuring for hot water, it's a little complicated because they are on appendix A so the SIR in theory has to be less than one so you have to be careful about which units

you're replacing. But recall that the SIR does not -- it needs to be calculated but not over one. So I'm thinking as I talk here. Greater than one. The circuit cannot be greater than one. One of the stipulations about circ. Go ahead. Someone might have a question on the line that's correct. Yeah, it's a gray area on a complicated issue with SERC. What we were sold by our general counsel is the way technologies can be eligible for SERC, for the expansion of weatherization programs. That is what SERC is all about. It's two things. One, technologies that aren't on what we call appendix A and two technologies if they are on appendix A they couldn't be installed. The only way technologies on appendix A can't be installed on WAP is if it's not cost effective on your audit tool. That's right. There maybe cases where this could come into play and you just need to make sure you're documenting that you did what you need to do to ensure that SERC funds and not lap funds should have been used to install this measure. Right. Okay.

Jerome Galiano: I only came across one or two of them out there. I don't know the safe products names. One of their options is that same looking unit can provide just domestic hot water or it can also switch between domestic hot water as well as producing hot water for the hydronic heating system. These technologies do exist. They're very new. I don't know if they're problematic. I haven't heard any negative things about them. I've heard they have in a couple cases were installed and have been fine but again it's only been out for maybe a year or two. At least for the one manufacturer that I've come across another question here is what about notice issues with heat pump water heaters. Yeah, that's true. It's gonna be just like a refrigerator. Every time that condenser kicks on, it's gonna sound just like your refrigerator.

If possible if it's gonna meet the manufacturer's spec insulation. If it's in an unconditioned basement, that's pretty warm in the wintertime. That way the notice isn't inherent in pressure systems will be at least out of the way. It basically it all about plumbing. Installing the -- if someone could just mute their lines please. Basically the equipment is essentially storage tanks. Back up heating auxiliary on one end then there is the collectors on the roof. I guess the question is could weatherization install the collectors on the roof? Yeah, I don't see why not. It's about

structural and mechanical and structural things and mechanical things. Is the roof -- installing is one thing, but you actually need someone that's done the proper analysis and design to know if that roof will bear that additional load? Sometimes the roofs have to be beefed up to bear the load depending upon the size of the system and the age of the roof. I don't know how to answer that question but I would say maybe you're assisting someone who's maybe caught some of the labels out here assisting someone who was a designer and primary installer. What other questions?

Tyler: Jerome, let me add onto that. Two things number one is Davis Bacon implication saw to whoever was doing that work whether it's weatherization crew member making sure you clearly define what their task is and the local agencies are paying the appropriate wage rates for those people. If it's not applying job, what tasks are they doing and do you have an approved rate to pay them through DOE and all that stuff. Second I forgot so go onto the next question.

Jerome Galiano: Okay. Do you anticipate any code problems in manufactured homes on demand water heaters? Again, checking with your local code, there's no reason it can't meet space wise especially if it's electric. I think you're probably thinking more about gas instantaneous water heaters. The main thing is having enough draw of combustion air. If you're not using a field combustion appliance. That maybe a problem in a mobile home. There's just not enough open free air space for sufficient combustion air in compliance with I guess NFPA and other codes. I'd check with your local code authority and maybe a way around that is a seal combustion where you're drawing air from the outside. That's it for the questions that people have submitted on Q and A.

Tyler: That's a really good point. It's gonna make any of these water heaters last longer just less fill up and -- but when it comes to the condensing ones especially instantaneous ones, there's just a lot smaller types and just a lot more possibilities. Much tighter tolerances. Once you have some scaling building up, that could limit flow which could cause it to stop working. I actually don't know a hard answer for you. I haven't seen examples of things failing because of water being too hard. Most likely the

manufacturer's have specifications for that whichever model you're looking at whether or not the manufacturer's rep. That really thinks about the installation cost for that job. The installation cost just went way up if you have to add a water softener. Better point there than a question because I couldn't really answer your question.

Jerome Galiano: Yes, we're supposed to do that with the storage water heaters. I don't know anyone who does that kind of flushing out, opening that valve at the bottom. Only that valve is corroded closed forever and if you open it up it's not shut off. It's much more importance on the indirect systems. The solar hot water system. Anything where you're spending a lot more money. These condensing technologies. Much larger heat exchanger inside of that tank. That's just much more surface for scale to build up on. Yes, having -- flushing it out. If it's got a sacrificial anode, that anode should probably be replaced every couple years. It's supposed to be replaced every couple years on conventional water heaters. Again, no one does that but if you want to protect and maintain the life of these more expensive technologies, then yes that's part of proper maintenance and should be thought of even factored into the cost. There might be homeowners who are elderly and there's no way they're gonna do it. Maybe you'll have to schedule maintenance for them. Thank you for the question.

Tyler: Yeah, circumstance funds are recovery act funds so Davis Bacon applies. That may be the weatherization assistant which could be their audit tool. Yes, there should be a way for you to use that audit tool if that's what indeed the question. Regarding appendix A, I can send a link out to that.

Jerome Galiano: That's true. You will be -- definitely. Probably humidifying the air to a certain degree. There might be additional benefits at the same time. The most important piece is that following manufacturer specs most of them save somewhere between 40 and 90-degrees. It's just like an air conditioner, it's gonna be more efficient the warmer the air is that's surrounding this heat pump is much closer to the temperature you're trying to meet. That's a really good point. I don't know about -- I guess it depends upon the use in the house and if the need of the dehumidifier is such that

there's enough standing water in the basement but it's just need seasonally. In other words yes, it depends on the scenario but yes, you possibly could dehumidify the air not that you wouldn't need that dehumidifier. That would be another way of looking at a more complex cost of savings analysis where now your savings are eliminating a whole appliance. Right.

Tyler: Yeah, those are the ones we're gonna have to make sure case by case. I understand a lot of states have priority list where hot water heaters may not be on it so in those states those agencies are currently not allowed to install hot water heaters so therefore it seems this would be an eligible application. Same thing in New Hampshire we saw that in your application originally where this specific type of hot water heater is not allowed by the state and therefore SERC money would be a good pot of money to use. So does that mean the water heating? Let me double check that's the case and get back to you. What's your name again, sir? I'll check with our general counsel and make sure that's the case.

Jerome Galiano: They do, but it's never come up on that particular multifamily heating systems. I'm not aware of any waivers that have been requested or granted for that. There's another question that came in from the Q and A from Carrie. Do you have any suggestions about monitoring devices for actual energy use by the water heater? Yes, the most precise but the very expensive depending upon the technology again if you're dealing with a gas fired system whether it's condensing or on demand it's difficult to really measure that gas without some kind of gas meter. It can be cost prohibited. There's a lot of indirect ways of figuring out how much or approximately how much gas is being used. Things that don't modulate.

These are like your indirect -- the on demand hot water heaters or instantaneous water heaters as well as I believe the new condensing water heaters. The flame modulates and can put out 40,000Btus or it can put out 100,000Btus per house hour. It's more difficult to measure indirectly but you can use temperature sensors or even a -- some kind of water that's basically checking for the coil or the ignition firing on and off. Some kind of -- tapping into the electrical system of the appliance water heater and seeing if the

water heater is firing or not firing and that device can then see -- that device can then be -- those hours can be added up to figure out the amount. Hours of things running you can take the Btu input and determine that number of hours times the Btu input and determine using on a weekly, monthly, or annual basis. Chief methods of doing indirectly, yes, but it might not be accurate especially for those technologies that have a modulating gas burner in which case it's pretty difficult to know how much gas is being used. Did that answer your question, Carrie?

Amy Hollander: If there are no more questions, I'm going to conclude the webinar.

Tyler: Yeah, well, please send me an e-mail. Do you have my e-mail? Okay. Send me an e-mail and write it out and then we'll make sure everything's good. Okay.

Jerome Galiano: Which hot water on demand hot water heaters are you looking at? Right. It's a great application and the other one who makes them where they have an integrated design to provide water for heating whether it's to a hydronic loof or a fan coil.

Tyler: Yeah, if you e-mail me I'll look back at your records and see.

Jerome Galiano: Let's see what ENERGY STAR says. ENERGY STAR doesn't address it directly. I don't know Tyler, do you guys have a -- I would assume it's a very well-insulated tank and you're talking about a condensing mod con boiler that's providing both the heat and heating up the --

Jerome Galiano: Right, I should clarify this presentation was about all the technologies with the conventional standard low efficiency like .5 or .55 energy factor hot water heater up to the solar stuff. Just get an understanding of what these things are for those maybe who haven't come across some of these in the field as well as the indirect system could be not very efficient at all. Poor design, poor piping, poor controls and a conventional boiler up to very, very efficient and producing the hot water at condensing mode. Most of those even when you have a mod con boiler making domestic hot water, most of the time it's not making the domestic hot water condensing. It's actually very difficult to do unless you have a large enough heat exchanger. So typical installation of those indirect systems are not superefficient. You eliminate another

combustion compliance but you're not running the boiler in condensing mode typically to produce that hot water.

Tyler: I'll work that with you an on individual basis. I think that's the best way to do it. Great question.

Amy Hollander: Thank you everyone for your questions. Are there any other questions? Last question. Thank you everybody. Thank you Jerome for hosting this webinar. You did an excellent job and I want people to know they can get the webinar slides from me if you'd like to e-mail me. My address is Amy. Hollander@ NREL.gov. That is spelled A-m-y.H-o-l-l-a-n-d-e-r@N-R-E-L.gov. I'll be glad to mail you the slides. It is taking us about two weeks to produce the webinars and get them up on the SERC website. If you need the information more quickly, I'll be happy to mail it to you. Also, I wanted to remind you we'll have another webinar on March 8, and details of that webinar will be coming to you soon from Tyler. Tyler, did you have any closing comments you wanted to make?

Tyler: No, just thanks to both you and Jerome for a great webinar.

Jerome Galiano: Thank you.

Amy Hollander: Yes, thank you, Jerome.

Jerome Galiano: My pleasure. Good audience.

Tyler: Thanks Amy. We'll talk to you soon.

Amy Hollander: Thank you. Bye-bye.

Tyler: Bye-bye.

[End of Audio]