DOE Office of Indian Energy Foundational Courses Renewable Energy Technologies: Direct Use for Building Heat and Hot Water Webinar (text version)

Below is the text version of the Webinar titled "DOE Office of Indian Energy Foundational Courses Renewable Energy Technologies: Direct Use for Building Heat and Hot Water."

Slide 1
Amy Hollander:
Hello, I'm Amy Hollander with the National Renewable Energy Laboratory. Welcome to today's webinar on Building Heat and Hot Water sponsored by the U.S. Department of Energy Office of Indian Energy Policy and Programs. This webinar is being recorded from DOE's National Renewable Energy Laboratory's new state-of-the-art net zero energy research support facility in Golden, Colorado.

This presentation on Building Heat and Hot Water is one of nine foundational webinars in a series from the DOE Office of Indian Energy Education Initiative designed to assist tribes with energy planning and development.

Slide 2
The course outline for this webinar will cover a slide on the DOE Office of Indian Energy Education Initiative, the course introduction, and three sections on renewable building heat and hot water using solar, biomass, and geothermal. At the end we will close with a snapshot of all the foundational webinars by the DOE Office of Indian Energy.

Slide 3
The idea for this training came from feedback from tribal leaders, tribal organizations, and other entities interested or involved in energy development in Indian Country. The DOE Office of Indian Energy is responsible for assisting tribes with energy planning and development, infrastructure, energy cost, and electrification of Indian lands and homes. As part of this commitment, and on behalf of the U.S. Department of Energy, Indian Energy is leading education and capacity-building efforts in Indian Country.

Slide 4
Foundational courses were created to give tribal leaders and professionals background information in renewable energy development that presents foundational information on strategic energy planning, grid basics, and renewable energy technologies; that breaks down the components of the project development process on the commercial and community scale; and explains how the various financing structures can be practical for projects on tribal lands.

Slide 5
For this webinar, I'll be your presenter. I'm a Project Manager at the National Renewable Energy Laboratory. I also have provided technical assistance in energy efficiency and renewables, as well as specialty energy efficiency and weatherization projects. My favorite projects at this time are offering technical assistance for the DOE

Office of Indian Energy, and a project to assist Argentina in developing a pilot weatherization program through the Clean Energy Solutions Center.

Slide 6

This webinar will focus on Building Heat and Hot Water renewables at the community and facility scale, but I will also review how the technologies function at the commercial level in order to offer perspective and knowledge. This webinar will especially focus on practical information and examples to help tribes select renewable energy applications to meet Building Heat and Hot Water needs.

Slide 7

You may ask yourself why address Building Heat and Hot Water. Although different renewables for Building Heat and Hot Water have a variety of advantages, there are absolute benefits that support the greater goal of clean and sustainability. Also many of these renewables can be designed for off-the-grid use, and in addition the expense of energy plants and infrastructures are reduced.

Reducing energy price, volatility, and fuel supply interruption are other benefits are also important. One of the most exciting benefits of renewable heat and hot water is the employment of local trades during the installation operation, and management. Regardless of all these benefits, the driving factor usually boils down to economics. Today renewable energy is rising in benefits, frequency, and cost effectiveness.

Slide 8

In this first section I'll review two types of solar. Solar thermal, which is the same as solar hot water, and also building heat technology called solar ventilation air preheat, which is sometimes shortened to the term solar hot air.

Slide 9

First we will review solar thermal. This map offers a color scale showing the savings to investment ratio, or the SIR for solar thermal systems compared to water heating with electricity. The SIR is the life cycle electricity cost savings generated divided by the solar system investment cost. If the SIR of a system installation is 1 or greater, it is cost effective, and that is indicated in shades of green on this map. An SIR below 1 is not quite as cost effective, and is indicated in red. So as you can see, solar thermal systems perform best in the southern regions, as well as a few northern areas with high electricity prices.

Slide 10

The most common types of solar thermal collectors are shown in this slide. The ethylene propylene diene monomer, or EPDM, is an inexpensive type of synthetic rubber material that is commonly used for swimming pool heating. It produces a heat differential from ambient air of about 10°C. Swimming pool solar water heating is typically cost effective in most areas.

The flat plate collector type is best for residential and community uses in colder climates because it is insulated. Extreme cold climates may need a secondary circulation fluid for further freeze protection. The evacuated tube collector is more efficient with less heat loss, although not as durable as the flat plate collectors.

The parabolic trough solar collector is typically used for industrial processes or large facilities with intense hot water needs, such as hospitals, correctional facilities, and factories. Parabolic trough collectors can heat water to 100°C or more above ambient air temperature. However, they do not do well in cloudy climates, and typically require ample land or surface area for installation.

Slide 11
This graph demonstrates how the local temperature range should determine the collector. The unglazed EDPM collector is best for 0°C to 10°C above ambient, flat plate collectors are best for 10°C to 50°C above ambient, and evacuated tubes are best for more than 50°C above ambient.

Slide 12
Solar thermal water heat and applications and collectors are categorized by the temperature at which heat is most efficiently delivered. There are a variety of solar thermal water heating applications. For low temperatures, swimming pool water heaters are cost competitive with both gas-fired and heat pump pool heaters, and they have very low annual operating cost. Solar pool heating is the most cost effective use of solar energy in many climates.

Medium temperature solar is used for residential water and space heating, including ventilating and air conditioning, or HVAC boilers, or hydronic heat applications. These can be for single and multifamily housing, or on a community scale such as cafeterias, laundries, and hotels. An example of residential space heating would be solar heating of water for a home boiler, or a hydronic heat system. High temperature solar can support industrial processes, but it is in the early stage of market deployment. Industrial temperatures are from 80°C to 250°C. Concentrating solar power collectors can produce utility scale electricity.

Slide 13
This slide gives another look at how solar thermal applications can be broken down into market sector uses for residential, community, industrial, and even water purification. Those in the yellow box are good candidates for tribes, and are proven products on the market. This includes community buildings such as hotels, multifamily housing, hospitals, recreational centers, swimming pools, and casinos.

Slide 14
Passive systems operate with standard domestic water distribution pressure, require no additional pumping, and are best in warm climates that stay above freezing. Active systems require additional pumping energy for the solar water heating system and a supplemental solar preheat storage tank. Here we see how solar water system types are

either passive or active. In both passive and active open loop systems, the heated water that comes out of the water tap and goes through the collector have minimal tolerance to hard or high mineral content water. In active closed loop system, the working fluid going through the collector heats the tap water through an additional heat exchanger. The more controller functions and pumps, the higher the maintenance cost. Active closed loop drain back indirect systems are the most robust configuration with two types of freeze protection, and one type of overhead protection.

Slide 15
Despite system options, solar water heating has a simple eight-step evaluation procedure. First you estimate the water needs to determine the amount of solar resource available, calculate the solar size needed, then calculate the annual energy savings and cost savings to figure the simple payback period. You can use this online tool, RETScreen International, to walk through these steps. This is a free Excel-based tool to help tribes quickly and inexpensively determine the viability of potential solar thermal projects.

Slide 16
And now we'll look at some fun examples of solar thermal. This is an example of a community recreation center where they use thermal hot water and solar pool heating. Creative financing was applied as a solar installation company will own, collect, and apply for the financial incentives such as tax credits and utility rebates, as well as build the system. After one year, the installation company sells it back to the city for a discounted price. Because of the utility rebate and DOE grant, the cost was minimal at $22,800.

Slide 17
This example of solar photovoltaics and solar thermal were placed on and near a 1970s recreation center to offset the enormous amount of energy that recreation centers need. Offsetting even a portion of a facility's energy generates significant savings of $1,163 per month. The solar thermal installation was expensive at $360,000, but it will save 9,360 therms, or $8,854 per year.

It is recommended by solar experts to first make the building energy efficient by weatherizing, then apply renewable energy resources to the structure. This building received updated HVAC equipment, including variable frequency drives, fan motors, chillers, boilers, and controllers. It also received insulation, air sealing, and low flow water devices. Cost and impacts for this solar thermal and PV system are covered in the next slide.

Slide 18
If offsetting 23% of this building's hot water and 6% of its electricity doesn't seem like much, think again. Both systems annually save $18,445, and yet the city did not utilize any of its on capital to fund the retrofits. This project was financed with an energy services company, or an ESCO. In this case the ESCO offered a plan for energy savings retrofits and renewables for multiple city facilities. The energy saving improvements were paid for by the ESCO, and the city's energy savings will repay the ESCO. At the

beginning of the project the ESCO calculates the number of years of energy savings and their profit margin to determine if the plan is viable. So simply said, the city chose a portfolio of their buildings to receive energy upgrades and renewables, then the energy savings pays the ESCO back for the financing and the ESCO earns a profit as well.

Slide 19
This slide gives some excellent references to ASHRAE standards that one could use when engineering a system. Also the SRCC has minimum standards for certifying solar water heating systems.

Slide 20
Now we begin the section on solar vent air preheat, known as solar hot air. Again we have the resources available to tribes, and you can see this as an excellent resource for probably any country not on the equator.

Slide 21
To get an idea of what a solar vent preheat air system is, these photos show good examples of how the technology functions as building siding and a very cost effective daytime heating solution. The brown warehouse building has solar preheat as its entire wall. The house has a smaller black panel mounted vertically. As you can imagine, southern exposure guarantees heated air.

Slide 22
This slide shows up-close photos of the technology. The actual building siding is the collector. The aluminum or steel panels have roll punch slots to intake the air.

Slide 23
This internal view of the solar vent preheat shows the simplicity of hot air collection through the perforated siding absorber called the transpired solar collector. The hot air distribution controlled by a thermostat is delivered to the building by ductwork, a fan, and a bypass damper. One may suspect the technology to attract excessive heat in the summer. One might ask if the building's cooling load is increased during hot months. Although no scientific studies have been produced, it is believed the system may, in fact, reduce the building's cooling load. There's enough porosity in the collector to allow the natural convection of air. The air enters at the bottom of the wall and is drawn upwards to escape. So instead of the wall plenum ending up acting as an air insulator, it makes it a good technology to withstand hot summer days as well as provide winter heat.

Slide 24
This is a side cut of the previous slide showing how the south-facing wall draws air into the perforated boundary layer. The air is then heated in a 4-6 inch wall cavity. Then it is drawn by the fan into the duct system. Again, during the hotter months, the heat is bypassed using dampers.

Slide 25

Advantages to this system is the low cost and the ability to integrate it into the building design. The equipment is also reliable, has low maintenance, and high efficiency.

Slide 26
This is an example of the solar vent preheat. The cost effectiveness is impressive and offers a payback of four years in this example. Many buildings incorporate this in their design for warehouses such as big box retailers and other large scale buildings.

As an aside, the photo on the top right shows the inventors of the solar vent preheat technology who happen to be NREL scientists. The photo on the bottom is from a recreational center in South Dakota.

Slide 27
This concludes our section on solar thermal and solar vent preheat using the transpired solar collector. These are resources for both technologies.

Slide 28
Again, here we have additional useful solar resources.

Slide 29
Now we'll explore how biomass heat can be a cost effective renewable for tribes.

Slide 30
Again, we start with the map showing viable resources in the United States, and this time more so in the east, in the western seaboard, and especially in the northeast in the Great Lakes area. This GIS map includes static data for several categories, resources by county, biomass per square kilometer, crop residues, forest residues, mill residues, etcetera.

Slide 31
This slide demonstrates how bio energy produces electricity and heat, but also gives life to many products from fuels to solvents, to detergents, and other chemicals as you can see in the yellow box. These photos also demonstrate how biomass feedstock such as yard waste, animal waste, and food oils can be made into combustion products.

Slide 32
The advantages to biomass energy are numerous. It is renewable, carbon neutral, and a dispatchable source of power and building heat.

Slide 33
Biomass has residential, commercial, or industrial applications. Biomass pellet stoves or fireplace inserts are considered a renewable technology. The top right photo shows a residential boiler and the ease of burning pellets over wood. The machines burn very clean as well. Commercial heating boilers can provide buildings with 100% heating needs during peak fuel production. Industrial boilers can be used in manufacturing where steam, hot water, thermal oil, and hot gas is required. The lower right shows an old coal-

fired plant that was converted to a biomass plant that clean burns oat hulls. Some utilities are interested in biomass heat and power, particularly in states with renewable portfolio requirements.

Slide 34
Pellet fuel appliances burn 3/8” to 1” pellets. Residential pellets are made from compacted sawdust, woodchips, bark, agricultural crop waste, waste paper, and other organic materials. Some models can also burn nut shells, corn kernels, and small woodchips. Pellet stoves have heating capacities that range between 8,000 and 90,000 BTUs per hour. They are suitable for homes as well as manufactured homes, apartments, or condominiums. All pellet fuel appliances have a fuel hopper to store the pellets until they are needed for burning. Most hoppers hold 35 to 130 pounds of fuel, which will last one day or more under normal operating conditions. A feeder device drops a few pellets at a time into the combustion chamber for burning. How quickly the pellets are fed to the burner determines the heat output. More advanced models have a small computer and a thermostat to govern the pellet feed rate.

Slide 35
For solid fuels like biomass, the boiler efficiency is strongly dependent on the moisture content of the fuel. Green, woody biomass typically has a moisture content of 40% to 60%. A moisture content of 50% means that a pound of fuel contains half a pound of wood and half a pound of water. Boiling off that water subtracts from the energy that would otherwise be available for heating and electricity production.

Other factors that affect the efficiency include the ash content, the amount of excess air, operating temperature and pressure, and fuel gas, or the exhaust temperature. Because of the contaminants in multiple solid waste-to-energy plants, WTE plants typically run at reduced temperature, which results in lower efficiency. A residential pellet stove will have higher efficiency because pellets have low moisture and ash content. A residential woodstove burning green wood would probably have an efficiency of 65% or less.

Slide 36
This is a photo of a biomass heat exchanger at a warehouse. Biomass works best where competing fuel prices are high. For many installations in the United States and around the world, facility heating capital costs are higher than for oil or gas HVAC systems, so savings must be achieved from the decreased bio fuel cost.

Slide 37
Biomass systems burn very cleanly. The table in the slide shows carbon dioxide emissions of 1.7 pounds of carbon for every ton of biomass burned. Due to an average 40% moisture content in wood, emissions may appear heavy, but visible steam is apparent. Compared to other disposal methods for this material such as wildfire or controlled burn, emissions from controlled heat and power biomass combustion is a compelling efficiency rate of 90%-95%.

Slide 38

Biomass siting and feasibility depends on many factors. The availability and affordability of feedstock is dependent on keeping the processing, handling, and transportation to a minimum. The competing cost of other fuel sources determines cost effectiveness also. If competing against fuel oil or propane, biomass makes sense. But if competing against the low cost of natural gas, it's harder for biomass to be cost effective. Backup or peak load systems may seem like an added cost, but really for a facility scale building, this allows you to undersize the biomass system, which decreases capital cost and improves efficiency.

For most parts of the country, peak heating load only occurs for a few hours per year, so the system can be sized at 60%-70% of peak load and still meet 90% of annual load. Backup systems can be natural gas or oil fired. Other items to consider when planning your site are the building size and type, the feedstock delivery routes and access, and the operations and management staff availability, and the local emissions regulations.

Slide 39
Residential biomass is very affordable, but more practical on a smaller scale such as a pellet stove or fireplace insert. A fireplace insert or pellet stove ranges from $1,700 to $5,000. A boiler ranges from $10,000 to $14,000. Commercial projects have a wide variance depending on project size. Industrial heating plants generally cost 350,000 per 1 million BTUs per hour. Smaller plants are more expensive because the operations and maintenance costs are higher, and the same number of personnel are required to operate them.

Operations and maintenance costs include fuel, operating labor, ash disposal (although ash can be used as fertilizer or soil amendment, but don't overdo it). Repair and replacement of parts like bearings, belts, augers, and other items.

Slide 40
The LCOE, or the levelized cost of energy for biomass-fired power plants can range from $0.06 to $0.29 per kilowatt-hour. The range is wide because costs vary and are dependent on capital building costs, available feedstock, and existing conventional power sources. If capital costs are modest, biomass can be a very competitive power generation option. Feedstock costs depend on low-cost agricultural and forestry residues and if wastes are available. Biomass can often compete with conventional power sources even where feedstocks are more expensive. So even with this wide LCOE range, biomass is still more competitive than diesel-fired generation, making it an ideal solution for an off-grid or mini-grid electrical supply.

Slide 41
This example is an NREL project in 2010 for the Kodiak Coastguard station in Alaska. This project worked beautifully and replaced the use of fuel oil at $4 a gallon. Troubleshooting the fuel source should be one of the early steps in choosing biomass. In this case, Kodiak Island has lots of trees, but no collection, processing, or delivery infrastructure for pellets. But they could receive pellets from the state of Washington or Canada.

After this system is in place, the demand could lead to a development of the local pellet supplied, which could spur additional pellet users, and start an industry in or near Kodiak. Pellet industry planning requires responsible forestry. The pine beetle-killed forest provide excellent fuel utilization of the resources from the unfortunate deforestation in the Western United States.

Slide 42
This biomass heat plant was installed here at NREL. The heat pump is the small building at the lower center of the picture. Chips are delivered through the rollup door into a chip bunker, and the boiler room is at the opposite end. The original design provided about 75% of annual building heat use for the campus, but the campus has since grown significantly. Contribution in 2011 was 46% of the heat load with the rest provided by natural gas. The heat delivery is an existing hot water distribution system. The cost was $3.3 million in 2008, and the savings per year is $400,000. So the simple payback calculates to 8.25 years. During the heating season it will burn a truckload of pine beetle-killed per day, and it stores four truckloads of woodchip fuel with an excellent payback. One of the only shortcomings of this renewable may be where to store the woodchips.

Slide 43
An RPS is a requirement that mandates a certain percentage of a utility's overall energy capacity or energy sales be derived from renewable resources. Some states include biomass for electrical generation, and a few include biomass for heating, but it's not as common. The DSIRE website, the Database of State Incentives for Renewable Energy, lists incentives and requirements for each state, plus federal requirements. Biomass is base load, so some utilities find it to be attractive to pair with wind or solar.

Slide 44
This slide shows some biomass resources. The Healthy Forest Act, or the HFRA, helps rural communities, states, tribes, and landowners restore healthy forests and rangeland conditions on their lands. The national Energy Policy Act of 2005 offers renewable requirements for government buildings.

Slide 45
Here are some more sources of information where you can learn about biomass resources and energy. Under the technology or the yellow tab here, the Woody Biomass Utilization desk guide, or the WBU, is an excellent resource with information to guide tribes in the development and establishment of woody biomass as a means of creating jobs, establishing infrastructure, and supporting new economic opportunities.

Slide 46
The final section of this webinar is on geothermal building heat.

Slide 47
This resource map shows low temperature resources for building heat and hot water. Geothermal has a very positive outlook in the United States. All the white areas are

suitable for geothermal heat pumps. The blue shows temperatures below 212°F, and the red, which almost covers the entire state of Nevada and some spotty coverage in the West, has resources above 212°F. Geo exchange, or ground source heat pumps, which is low temperature geothermal can be cost effective anywhere in the country depending on soil type and drilling cost, and the cost of the energy being offset. So obviously a location with dense rock in the ground will have high construction drilling costs, whereas a site with agreeable soil and possibly warm water will complement the technology.

Slide 48
This slide illustrates examples of community scale productions. There are many potential uses of geothermal energy, both passive and active in nature. Direct use as defined by this webinar will focus on heat and hot water applications, but upcoming there is an example of agriculture and aquaculture.

Slide 49
Geothermal heat pump systems do not create heat energy; they move the heat between the building and the ground, while a conventional furnace converts oil, gas, wood or electricity to heat. A geothermal heat pump utilizes the natural heat of the earth for cooling in the summer and heating in the winter months. In most applications a backup heating unit to supplement the heat pump in cold weather may be necessary.

This slide also shows the different types of loops that can be selected. The type of loop installed is based on the property itself, available land, and installation costs based on geographic location. Not shown is how the loops can be vertical, horizontal, or located in an adequately sized pond or body or water.

Slide 50
Geothermal systems can provide all or part of a facility's household's hot water. An economic way to obtain a portion of domestic hot water is through the addition of de-super heater, or the geothermal unit. A de-super heater is a small auxiliary heat exchanger that uses super heated gases from the heat pump's compressor to heat water. This hot water then circulates through a pipe to the building's water heater tank. In summer when the geothermal system is in the cooling mode, the de-super heater merely uses excess heat that would otherwise be expelled to the loop. When the geothermal unit is running frequently, homeowners and building owners can obtain all of their hot water in this manner virtually for free. A conventional hot water heater meets household hot water needs in winter if the de-super heater isn't producing enough, and in the spring and fall, when the geothermal system may not be operating at all.

Because geothermal systems heat water so efficiently, many manufacturers today are also offering triple function geothermal systems. Triple function systems provide heating, cooling, and hot water. They use a separate heat exchanger to meet all of the household's hot water needs. The EPA has stated that geothermal heat pump systems are the most energy efficient, environmentally clean, and cost effective space conditioning systems available.

Slide 51
An example of a small commercial project that has potential applications for many community-based projects is shown on this slide. The Chena Hot Springs resort in Alaska is located about 60 miles north of Fairbanks, and has harnessed geothermal resources for a variety of uses, including the generation of electricity, space heating for the resort, heating of the greenhouse, which grows fresh fruits and vegetables for the resort's restaurant, and heating of the hot springs. The resort is essentially self contained and off the grid through geothermal energy.

Slide 52
This slide depicts the six-part strategic energy project plan used to supply 50% of the energy needs to power the Potawatomi Cultural Heritage Center.

Slide 53
The Citizen Potawatomi developed a strategic energy plan and accomplished multiple energy solutions for this tribal community. It supplied a sustainable business venture that provides 50% of its energy needs in three large structures through a clean and cost effective geothermal energy source. It provides jobs, is low maintenance, and cost effective. The Grand Casino building was so successful that they are now building a bowling center, an arena building, and 70 housing units that will be supplied with geothermal heating and hot water.

Slide 54
Here's an example of geothermal technology for a school demonstrating how a ground source heat pump can be less expensive than a conventional system. This 123,000 square foot school installed a hybrid horizontal closed-loop system, and matched it with a solar wall and a natural gas fresh air preheating system. The installation costs were $589,000, saving approximately $210,000 on the cost of a conventional system. The school saw an 8% reduction in energy use compared to conventional systems operating at other schools in the area.

Slide 55
Costs of geothermal are extremely varied and depend on siding, soil, workspace, and local economies. Here's some ranges and examples for residential and community scale.

A new construction residential system can cost anywhere from $15,000 to $20,000. An existing residential structure can be more expensive due to complex heat delivery, and may run as much as $30,000 for heating and cooling. Community scale examples include a middle school system built for $1.3 million, and $860,000 spent on a ground source heat pump added to a community college. A geothermal power plant in Nevada costs $4.4 million and could compare in size to a tribal independent power plant.

As noted before, the most cost effective region for geothermal is in the South, Midwest, and Mid-Atlantic regions of the U.S. Also, please note that hybrid systems coupled with cooling towers and boilers can make systems more cost effective.

Slide 56
This chart illustrates some general costs associated with electric generation projects and geo-exchange applications, including residential, commercial, and schools. The cost for developing a power plant can vary widely and are highly dependent on the type of project, plant size, site accessibility, and location, well-performance, as well as time delays and other items. The geo-exchange data came from case studies published online at Geoexchange.org referenced at the bottom of this page.

These are average costs and can vary widely depending on local economies, ground temperatures, and the size of the building just to name a few. As would be expected, the larger the project per square footage or per ton of thermal capacity, the lower the cost. Note this is a very cost effective technology for heating and cooling.

Slide 57
Here are some more sources of information where you can learn about geothermal resources and energy.

Slide 58
This slide has additional information on geothermal resources and technology that can be found on these websites.

Slide 59
We've now completed this webinar on Building Heat and Hot Water Technologies. I hope it's given you information and ideas about how you can provide heat and hot water to tribal residents of the residential community, and commercial scale. The four technologies selected today provide cost effective training that will lead to clean energy, which means clean air and clean water, economic sustainability, and economic development.

Slide 60
I now want to turn your attention to information on the curriculum program and offerings of the DOE Indian Energy Education Initiative Education Program.

Slide 61
The DOE Office of Indian Energy has two areas of instruction. The foundational courses were derived from a desire to provide basic information on renewable energy technologies, strategic energy planning, and electricity grid basics. These courses will hopefully help tribes formulate ideas for renewable projects that fit their needs and resources best.

The leadership and professional courses offer more detailed instruction on specific components of the project development process in existing project financing structures.

Slide 62

This slide shows all the foundational courses offered by DOE's Office of Indian Energy. You can find these at the DOE Indian Energy website, and they offer an excellent way to learn the basics in 30-40 minute webinar presentations.

I hope this webinar offered you enough information so you can begin planning for renewable energy products. Again, please email us at IndianEnergy@hq.doe.gov if you have any questions or technical assistance. Thank you for your time and attention today.

[End of Audio]