DOE Office of Indian Energy Foundational Courses Renewable Energy Technologies: Biomass Webinar (text version)

Below is the text version of the Webinar titled "DOE Office of Indian Energy Foundational Courses Renewable Energy Technologies: Biomass".

Amy Hollander:

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

Our biomass presentation today is one of nine foundational webinars in the series from the DOE Office of Indian Energy designed to assist tribes with energy planning and development.

The course outlined for this webinar will cover the DOE Office of Indian Energy Education initiative that is sponsoring this webinar. Also a course introduction resource map and project scales, technology overviews with siting and cost information, successful project examples, and policies relevant to project development. Also, additional information resources will be at the end.

At the start of every section, this course outline will mark the new section. 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 in capacity building efforts in Indian country.

The foundational courses were created to give tribal leaders and professionals background information on 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 that explains how the various financing structures can be practical for projects on tribal lands.

And with that, I'd like to introduce today's speaker, Randy Hunsberger. Mr. Hunsberger has been a mechanical engineer for twenty-five years working in renewable energy since 1999. He spent three years working at NREL's national wind technology center while obtaining his Master's degree in civil engineering from the University of Colorado's building systems program. He then spent eight years consulting in biomass heat and power projects around the country before returning to NREL in 2010. Mr. Hunsberger has been involved in studies for landfill gas, solar, geothermal, and wind energy projects. Mr. Hunsberger's biomass work has included a variety of project types, including heating, power production, CHP, solid waste, biomass densification, and waste energy.

And with that, I'll turn it over to Mr. Hunsberger.

Randy Hunsberger:
Thank you, Amy, for that introduction. The next part of this presentation is going to cover an introduction to the biomass heating and power, and then I will present some maps and scales for a resource.

Biomass heating and electric power is considered to be a form of renewable energy generation. Biomass energy is considered to be carbon neutral in the near term, and it is a base load or dispatchable source of heat and power. Other forms of renewable energy like solar and wind are unpredictable in their generation, and you can't really control when they're going to be producing and at what level. But with biomass, biomass heat or power systems act more like traditional solid fuels or natural gas systems in that you can control their operation and turn them up and down as you need to.

This presentation is also going to cover a little bit about some of the intermediate products that you can produce with biomass like pellets and torrefied fuel. One of the most important factors in any biomass project is the resource supply, and I'm going to mention this several times during this presentation because it's very important. Biomass heat and power are both considered to be commercial in proven technologies, particularly combustion, but some newer technologies that are even cleaner and high efficiency have been developed and are slowly making their way to the U.S.

So as I mentioned before, one of the important factors in the success of any biomass facility, whether it's heat or power or pellets, is the availability of appropriate resource. So one of the first steps in determining whether biomass makes sense for your facility or for your application is to do a high level resource assessment to see what kind of biomass resources might be available in your area.

This slide lists a couple of different NREL tools that are freely available that anybody can use to look for biomass resources in their area, and I'm going to briefly go over them in the next slides.

The image in this slide is from one of the biomass GIS maps that are available from the website listed on the previous page, and it shows county level data for all types of biomass resource. On that same page are numerous different types of maps for different types of woody biomass and agricultural residues. Two of the links on the previous slide are for biopower and biofuels atlas, which are other NREL tools that are more interactive and allow you to work with GIS data to determine specific resources available in any particular area. With these maps you can turn and off different resources, and you can zoom into areas to determine what's available and what the competing uses are for those same products.

Biomass comes in a large range of sizes. For this webinar we're going to focus on commercial and community scale projects. What that means for heating is we're looking at systems maybe about 1½ million BTU per hour and larger. These would be appropriate for, for example, hotels, schools, casinos, recreation centers or office buildings. And you can also use this for district heating systems that might encompass residents or even other types of facilities.

Biomass power is available in a range of sizes up to fifty and even 100 megawatts, but for the larger systems, you really need to go out a long way to get enough biomass resource to refuel the facility. For the purposes of this presentation, we're focused mostly in the range of say one to ten megawatts which would be an appropriate scale for let's say a lumber mill or village power, or even a casino. For specific technologies like anaerobic digestion or landfill gas, there are small technologies available. The next part of the presentation is going to give a technology overview, including siting and costs, and it's going to give a couple examples of successful biomass projects.

There are many uses for biomass, and many different materials that can be considered biomass, making biomass a very complex subject in the world of renewable energy. Some of the primary uses that we're going to cover today include facility heating, electric power generation, and combined heat and power. Biomass feedstocks can include woody biomass, agricultural residues, animal and human waste, municipal solid waste, and landfill gas.

This slide has three columns. The first column shows a range of biomass feedstocks that can be used in various types of biomass projects. The far right column shows some of the products that you can make from biomass, including fuels, chemicals, heat and electricity. For the purpose of this presentation we're really just covering the heat and electricity.

The middle column shows the conversion processes to get from the feedstock to the final product. Of these, the top four are considered thermo-chemical and the bottom four are biochemical, meaning they use bacteria or enzymes or other living organisms to convert from one to the other. Of these, the one that's considered the most commercial is combustion. Gasification and pyrolysis are used a little bit, but they're not widely developed. They are some of the newer technologies that I mentioned earlier that are becoming more readily available in the United States.

Cofiring is burning biomass with coal. Cofiring. One of the benefits of cofiring to the utility is it allows them to be able to use biomass without having an extensive investment in capital technology. They can often just use their existing equipment with maybe some minor modifications to the fuel handling equipment. That way if the biomass doesn't work out, or if they can't get feedstock, they can just switch back to coal, and they haven't spent a lot of money on new equipment.

This slide briefly discusses some of the important factors to consider when looking at feasibility of a biomass project for your facility. As I mentioned earlier, it's very important to have the correct biomass resource for your facility. It wouldn't make sense to specify equipment before you know what type of biomass you have available. It's also important to know how that biomass can be collected and delivered, and what the cost is going to be.

Another thing you need to consider on a biomass project is your cost of competing fuels. For example, if you're doing a biomass heating system and you're competing against expensive propane or fuel oil, then it's highly possible that biomass will make sense for you. But if you're competing against cheap natural gas, it's going to be a lot harder for a biomass project to compete financially.

You also need to look at your thermal loads, both your peak and your annual load. Typically when sizing a biomass system, particularly if you're replacing an existing oil or gas fired boiler for example, it's often beneficial to keep that old equipment if it's still serviceable and use for the backup system and to supply your peak load.

This allows you to undersize your biomass system and still meet most of your annual load. This has a lot of benefits. It decreases your capital cost, and it improves the operating efficiency of your biomass equipment.

Another important factor is to make sure that you have sufficient space available in your building for the biomass equipment. Biomass heating systems in particular are much larger than oil or natural gas systems, both for the boiler itself, and also for the fuel handling and the fuel storage equipment. So you have to make sure you have space available. And you also have to make sure that trucks delivering biomass have access to the facility. That they can easily get to where the fuel needs to be delivered, and that they can maneuver and get in and out safely. You also need to look at the operation and maintenance staff availability, and to ensure that the staff can handle whatever type of equipment you install.

And finally, you have to look at local admission regulations. Biomass systems burn very cleanly, and we're going to talk about emissions in another slide, but there's still some localities where the emission regulations might preclude installation of a biomass facility.

Biomass boilers typically operate at an efficiency of about 60-65%, but that's highly dependent on the moisture content of the fuel. Typical green biomass, for example, a tree that was just recently cut down, will have moisture content in the range of 40-60%. And what that means for example, if you have a pound of wood with 50% moisture content, you really have half a pound of wood and half a pound of water. And it takes a lot of energy to evaporate that water and drive it off. So that's less energy that's going to be available for facility heating or power generation.

So other things that influence the efficiency of a biomass system, to some extent the ash content. Also, the combustion air distribution and quantity. You need a certain quantity of air to completely combust biomass, and to ensure complete combustion, usually excess air is included. But the higher the excess air, the more efficiency loss that you take.

Another important parameter is the operating temperature and pressure, particularly for a biomass power system. The higher the temperature and the pressure is, the more efficient the system. One of the potential fuels for biomass is municipal solid waste, and because of contaminants in the municipal solid waste, that often has to be used at a lower temperature and pressure, and so it usually has lower efficiency.

And finally, the flue gas temperature, the gas going up the exhaust, the hotter that is, the more energy you're losing and so that'll decrease your efficiency. There are some things that can be done. For example, using an economizer that can recover some of that heat, but you can't recover all of it.

For electric power systems, the most commercially available system is combustion with a steam turbine. The efficiency of these systems are fairly low. They tend to be in the range of 15-30% if you're only producing electric power. If you're producing combined heat and power, you can recover some of that energy and raise your efficiency to 60% or even 70%. And of these combustion systems, the most commonly used in the U.S. are stoker and fluidized bed, and there's about 500 such facilities in the U.S. Largely at places like lumber mills and other places where the resource would otherwise be a disposal issue, and where they have high electric and thermal loads.

There are two pictures on this page. The top one shows a truck dumper dumping a semi load of chips. This is most likely at a large facility like a biomass power plant where investment in this kind of equipment is worthwhile. The lower picture shows two steam turbines.

Combustion of biomass does result in air emissions. These air emissions depend on the system's design, fuel characteristics, operation and maintenance factors. The table on this page shows typical emissions from a biomass heating system. This one happens to be based on chip degasifier data operating on 40% moisture content, pine. These are the four criteria. Pollutants particulate matter less than ten microns, oxides of nitrogen, volatile organic compounds, and carbon monoxide. Carbon monoxide is a result of incomplete combustion, so the better your combustion is, the lower your CO will be.

When looking at a biomass system, it's important to look at the alternative disposal methods for that biomass. If you're trying to estimate emissions, you really should be looking at your net emissions. If the alternative disposal method for this material, for example, is going to be controlled burn, or pile burn, or even a wildfire, those types of uncontrolled combustion result in emissions much higher than these controlled emissions. So by taking that material into a control combustion, you can reduce those emissions between 90-99%.

I'm going to talk briefly about cost for biomass systems in a very generic sense. For an electric system, install costs about $1,900 to $5,500 per kilowatt. Of course, these are very general numbers. The larger the system is the lower the cost intensity. So as you get to a small system, the cost per kilowatt goes way up.

Levelized cost of energy, LCOE, is the entire cost of operating a plant over its lifetime divided by the total amount of energy that it produces over that same lifetime. So for an electric power system, the LCOE is typically between 8¢ and 20¢ per kilowatt hour. Now keep in mind that this is highly dependent on the cost of the biomass. A typical biopower scale for a tribal or community application would probably be say ten megawatts, and would cost in the range of $40 million. An LCOE for a system of that size is maybe 10¢ to 12¢ per kilowatt hour.

Biomass heating plants, similar to electric plants, but smaller plants have a higher cost intensity than large ones. A typical heating plant might cost in the range of $350,000 per million BTU per hour. Again, this is very site specific, and it's just a number to give you a general feel for what a plant like that might cost.

Operation and maintenance costs for a biomass heating plant include fuel, labor, repair and replacement of mechanical parts, and ash disposal. The labor required for a biomass heating plant is fairly minimal. Usually about two to five hours per week, which includes ordering fuel, walking through daily to check equipment to make sure, for example, there's no broken augers, and inspecting the fuel when it arrives. Some of the typical parts that might wear out over time would include bearings, belts, and augers.

For ash disposal, if you're just burning clean woody biomass, that's actually considered a soil amendment and you can use that, for example, on a soccer field or a farm field, but you don't want to overdo it.

Here's an example plant. In 2010 NREL worked with the Kodiak Coastguard up in Kodiak, Alaska to investigate the feasibility of replacing their existing oil-fired boiler with a biomass system. Even though Kodiak and the nearby islands have a lot of wood, there is no infrastructure developed to harvest that wood, to process it, and to deliver it to the site. The system that NREL investigated for replacing the oil-fired boilers was a pellet system that would powderize the pellets and blow them into the boiler. Unfortunately there's no infrastructure available on Kodiak for pellet delivery either, but pellets we discovered could be shipped either from Canada, or even from Washington state, and the cost would still be less than using fuel oil.

One of the hopes was that over time the industry would develop beyond Kodiak, or a nearby island, to produce pellets and supply it to the base, and that similarly other local users would develop to use this material. Some of the benefits of this are reduced fuel cost, improved operations and resiliency. Using pellets would help support energy independence, particularly if a local industry developed. It would also foster environmental stewardship.

One of the important factors for a project like this to be successful would be that the supply and manufacture of pellets would be sustainable, meaning that the amount of biomass harvested in any year wouldn't exceed the amount of biomass that could be generated.

This slide shows another project example. This one is installed here at the NREL campus. It was installed in about 2010 to provide heat to the research buildings. It was initially intended to provide about 75% of the annual heating use for the campus, but the campus has grown significantly since then, and the contribution in 2011 was about 46% of the heat load. The rest of the heat load was met by natural gas.

This system is nine million BTU per hour and it's tied into the existing hot water distribution system. The picture shows the biomass heating facility, called the RFHP, and it's just that small building in the lower center of the picture. The big rollup door on the left side of the picture is where the chips are delivered. There's an underground bunker with augers in the bottom that transport the chips into the boiler, which is at the opposite end of the building. That entire building is maybe the size of a large RV garage, so it's not very big. And because of restrictions with underground utilities surrounding the building, they can't really extend it any larger. The cost for this facility was about $3.3 million in 2009 I believe.

The next slide is going to cover policies relevant to biomass project development. About thirty states have enacted renewable energy portfolio standards primarily covering electricity generation by biomass. There are some states that include biomass heating, but that's a lot less common because it's harder to monitor thermal usage, and harder to meter it. As with biofuels, many biopower incentives have been passed on a state level to encourage bio power production. There's a website called DesireUSA.org which lists incentives for renewable energy projects state by state and Federal. The website is here on this.

There's also some Federal policy-related to biomass projects both heat, thermal, and fuel. Some of them are listed here. For example, the USDA Farm Bill. The Healthy Forest initiative. U.S. Energy initiative, and the National Energy Policy Act of 2005.

The Healthy Forest act helps rural communities, states, tribes, and landowners restore healthy forests and range land conditions on their land. And the National Energy Policy Act includes a renewable fuel standard.

Randy Hunsberger:
Our final slides are going to cover additional information and resources that are available for biomass projects. This slide lists some websites and tools that are available to help you evaluate resources, technologies, and policies for biomass projects. The woody biomass utilization includes the policy principle to support Indian tribes as appropriate in the development and establishment of woody biomass utilization within tribal communities as it means they're creating jobs, establishing infrastructure, and supporting new economic opportunities. Thanks for your attention. My name is Randy Hunsberger.

This slide lists my contact information. If you have an idea for a biomass project and you need some help on it, feel free to contact me or go to one of the two websites listed on this slide.

Amy Hollander:
I now want to turn your attention to information on the curriculum program, and offerings of the DOE Office of Indian Energy education program. There are two series in the program. The foundational courses, and the leadership or professional courses. The foundational courses give basic information on renewable energy technologies, strategic energy planning, and grid basics. The leadership and professional courses cover more detail on the components of the project development process, and existing project financing structures.

The foundational courses are divided into energy basics and renewable energy technologies. Energy basics include assessing energy needs and resources based on a tribe's location and available resources. Electricity grid basics review the types of the utility grids in the United States, and resources of how tribes can tie into or be independent of the existing power grids. Strategic energy planning teaches the steps to take when setting up renewables.

The renewable technology webinars give basic information on the types of renewable that are successfully used in today's world. Be sure to visit the DOE Office of Indian Energy website to find these webinars and other tools. And that concludes our webinar. Thank you for your attendance.

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