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

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

Amy Hollander:
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 educational and capacity building efforts in Indian country.

The 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 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, Charles Newcomb. Mr. Newcomb is the section supervisor for wind power deployment at the Energy Department's National Renewable Energy Laboratory. He is a member of NREL's leadership team for strategy, research and deployment, and has over fifteen years of experience in all phases of wind energy.

Mr. Newcomb is a principle investigator for the research and deployment portfolio. He has also managed project permitting, interconnection, equipment selection, procurement, wind turbine fleets, and operation and management strategy. Mr. Newcomb has also managed leading edge resource assessment campaigns, and led technical assistance trainings for utilities policymakers and regulators. And with that, I'll turn it over to Charles Newcomb.

Charles Newcomb:
Amy, thank you for that introduction. So going forward what we'll cover is a brief course introduction, a description of some key takeaways for the technology, and a brief discussion of the wind resource map of the United States.

I'd like to introduce you briefly to what we do at the National Wind Technology Center here at DOE's National Renewable Energy Laboratory. At the National Wind Technology Center we research, we conduct some fundamental research on wind energy, including air acoustics, air dynamics, air elastics. We run fundamental models. We develop control codes. We have various platforms for vendors that are developing control codes and want to know that the equipment will operate using those codes. We also test components, and in this graphic you can see there's a couple of images. The left-hand image has the image of a drive train, actually what's inside of a wind turbine, under test at the National Wind Technology Center. And we have the capability to test turbines currently up to 2.5 megawatts with a five megawatt dynamometer under construction now. There's also a photograph there of a blade being set up for a test. We can test blades up to about fifty meters in length for both ultimate tests to make sure it's not going to hit the tower if it gets a really strong gust of wind, but also fatigue tests to know that the blade will go through an entire lifespan without sustaining any damage.

And then we finally conduct a fair amount of full system tests in turbines ranging from small residential turbines that are good for houses, on up to these utility scale turbines. Finally, we also provide some technical assistance upon request, and that includes for tribes.

Slide eight is a slide that shows that depending on the type of project and the scale of the project, how you might choose a different technology or technology type. And because wind energy has a continuum of turbine sizes from very small, so some of these turbines can fit on your sailboat or your small cabin, up to the very large with rotor diameters approaching 135 meters and larger. Because of that, that spectrum of turbine scales we can activate our technology in a variety of market spaces, and resource spaces.

As we go through this presentation, I'd like you to think about a few key takeaways that are worth considering. Number one, wind energy is a mature technology. It's been around for decades, but that doesn't mean that it's been static for that time. In fact, it's evolving and evolving rapidly. Even in the past two to three years we've seen turbines' rotor sizes not quite double, but certainly go up by 50% for the same generator size. So these new technologies are able to access lower energy wind resources than we ever imagined possible even just a few years ago.

And as I mentioned earlier, wind also does come in many sizes, so it's appropriate across a whole range of business models. Wind is cost competitive in many locations around the United States, and abroad of course, and it's important to understand that wind, depending on where it's installed on the utility grid and what market it's installed in, why it's competitive. So when it's installed on the utility grid at a transmission level like a large central station power plant or a wind farm, then it's competing at a very low price point of a few cents – 4¢, 5¢, 3¢ per kilowatt hour. And when it's installed in your backyard at your home, it's offsetting retail rate power which is obviously considerably higher.

Wind energy with large turbines does require the engagement of stakeholders in the surrounding area. Because these are large infrastructure structures that can be some of the largest in the area, they exceed 450 feet in many cases – because that's the case, you have to make sure it's really important to engage the local landowners. It's not just a matter of the host landowner and the utility and the bank. It's all the people around that can see it. And of course, you're trying to balance that with the notion that just because you can see it doesn't mean it impacts you negatively. There's a lot of things that you can see that may or may not impact you depending on how close you are to that turbine.

This slide shows a couple of maps. One map on the left-hand side is the map of the United States. These are numerical weather prediction models that connect the dots between known measurement locations where the wind energy actually has been measured by a physical means and not mathematically modeled. The map on the right-hand side has a zoom-in of an area near Casper, Wyoming. To give you a sense of these numerical models actually can drill down to about the 200 meter level, so they're very powerful prospecting tools for developers and homeowners alike.

The map on the left is the eighty meter map that we currently have developed, but we also have a thirty meter map that's good for residences. And these maps can be downloaded at the link included on this slide.

This slide shows the intersection between the wind resource and the tribes in the contiguous U.S., and there's clearly a nice overlap, and an enormous opportunity for wind development across tribal lands in the United States. What's not shown here is the intersection for tribes and the wind resource in Alaska, and that's also a rich intersection, and some of the best examples of community power projects in high cost of energy locations in remote areas of Alaska, those are some of the best examples of those types of projects in Alaska.

So now that we have a sense of where this resource is and how abundant and ubiquitous it is across the United States, I'd like to spend a little bit of time talking about some of the elements for project success in terms of siting, but also a little bit more about scale and how scale drives cost and economics.

So what we're showing here in this slide is the two ends of the spectrum. On one end you have this small onsite let's call it a residential project, and on the other end you have a commercial or merchant project that's a wind farm of substantial investment. You can imagine how in one case, the residential case, the business case doesn't need to be as strong – it's a choice – as it does when you're involving hundreds of millions of dollars and you're affecting the entire tribe.

So thinking about the residential space, you do in fact need to make sure that you do have a resource, and that's what the wind maps are good for, especially the small scale project size. You also have to know that you have a place to put it. You need to have a location where the project will have an access to the wind resource that's above you.

The business case asterisked here is a little bit optional as I mentioned. In many cases these can be a fifteen, or in some cases a ten-year payback, but sometimes a twenty-year payback, and sometimes there is no business case whatsoever and yet individuals will choose to do a small wind project on their home because they're more attracted to the environmental stewardship side of it.

From a siting perspective, on the approvals and agreements, it's always important to be working with your local permitting officials to make sure that what you're doing with your wind project is of permanent use. That you, in fact, can get conditional use permit or there's an existing ordinance that describes how and where you can do projects on your land. And then finally, if you are going to connect it with the utility, then you have to have their approvals as well, their agreements, to interconnect with them.

From a financing perspective on a small residential household project, you simply need to have the cash, or you have to have the credit to purchase it. And you have to have – this has to fit within a reasonable risk for your own personal finances. So you don't want to invest in something that's going to cause you to go down.

On the other end of the spectrum things can get a little bit more complicated. Again, it's not just that yes, I know I have a suitable wind resource, but I have to be able to demonstrate that resource to my financiers, to the bank itself. I have to make sure that I have reasonable market access, meaning I have somebody who will take the power, and that the conditions of that sale won't change over the life of the project in unexpected ways. I definitely have to have a strong business case, and that means that the cash flow for this project will support the debt service requirements. And I have to have reasonable land, I have to have suitable land. And it's not just that it has access to the wind resource as in the prior case, but it also has to be land that meets all the requirements from a historic preservation perspective, or an environmental perspective at large.

From the approvals and agreements side – and this is again meant to be a less sort of not completely comprehensive, but from an approvals and agreements side, on the siting, again you need to make sure that you've characterized what the impact on neighbors will be. That you've characterized what the impact on the utility will be. That you've done your grid impact studies. Because no financier is going to bring money in if they think later on there could be a lawsuit with regards to those kinds of elements. There needs to be interconnection agreements signed and power purchase agreements signed before banks will come to the table. And speaking of banks, it's not just any bank. You need to make sure on the finance side that you've got a bank that's familiar with the technology, familiar with the market space, familiar with the variability of the wind resource, understands what sort of debt service coverage ratios are typical, and what they mean for them. And that that whole risk portfolio fits within what they're willing to work with.

So as we think about this spectrum of wind project sizes, I'd like to spend a moment describing in a little bit better detail what I mean by these various sizes. So remote power is something that we see for remote water pumping for livestock, or perhaps remote telecommunications out on a hilltop somewhere. Or for remote communities up in Alaska, or even in some other rural areas where it's far from the electrical grid.

On-site energy is, I'm calling it distinct in this slide as being similar projects, but those which are connected to the utility grid. And those again can be residential, and you have residential off grid as well. Commercial, which would be a school, or a community center. And perhaps some industrial where you actually have I would call a brewery industrial in fact. Or a casino might be on the border between commercial and industrial.

And then finally energy for sale. These are projects where it's merchant power or a power purchase agreement. You're selling power directly to the utility at a transmission level or a medium voltage distribution level. And these are using utility scale turbines that are laid out in a cost effective grid system.

So to illustrate the sense of scale and how these are different, on the left-hand side is a photograph of a residential turbine. That particular turbine happens to be 2.4 kilowatts, and you could take it apart and put it in the back of your pickup truck for sense of scale. On the right-hand we have two technicians who are standing on top of a wind turbine. And you can see that the nacelle, or the housing that holds the drive train of the turbine and holds the blades on, is about the size of a large motor home. So these machines can get large, very large, and in fact, this GE 1.5 megawatt machine, of which there are many thousands of them out in the U.S. fleet, is getting on the small side. It's about half the size of some of the standard machines that are going into projects today.

When we think about wind energy, something that comes up often is how much energy will my system produce? And that really depends on how big your system is, and how that system will perform. Now, you'll see here that the capacity factor, which is the fraction of how much energy actually gets produced in the numerator, and in the denominator how much energy could be produced if that unit was running all day long every day of the year. And that all day long, every day of the year actually twenty-four times 365 is equal to 8,760. So you'll see that number come up every once in a while.

That fraction typically is lower for smaller projects than it is for larger projects, and that really comes down to the height of the tower. Large turbines, as I mentioned earlier, can be installed on towers that are 100 meters tall, so over 300 feet tall. Whereas small turbines are installed on towers that are typically less than 120 feet tall. So it's a question of ground clutter. It's a question of the quality of the wind resource. So you could put a small turbine on a big turbine tower and it would get a similar capacity factor as to a large turbine. But you can never afford the tower. The tower itself is really expensive. And that's why small turbines are on short towers.

So those are some general capacity factors that you'll see in the industry. And these capacity factors are affected by a few things that are out of your control. Temperature. You really don't have control over that. When it gets cold, the air gets more dense and the performance goes up. When it gets hot, the air gets less dense, and the performance goes down. Altitude as you know, those of you who have traveled to higher altitudes know that air that's higher up is thinner, and less dense, and therefore, you have less performance at higher altitude than you do at sea level.

And then there's some things that are within your control. Siting the turbine. Putting it in higher locations on hillsides as opposed to in valleys. That's important from a performance standpoint, anyway. And putting it away from obstructions. Putting the turbine so it's not downwind of a tree. That makes obvious sense, but you'd be surprised at how many people wonder why their turbine isn't making power, and when you go to visit it, it's inside the trees. It actually does take typically eight miles per hour, nine miles per hour for most wind turbines to actually start making power. So even though you can feel a breeze in the woods doesn't mean that's enough wind to really make much power.

And then roughness. So even if you get it above the trees, it's important to be well above the trees in order to get access to the best resource. And well above is somewhat subjective, because it depends on you know, how smooth of a forest canopy you have. But generally speaking, thirty feet that we used to think was enough is maybe not so much enough. Maybe fifty feet, maybe sixty feet. But it all depends on what you're after and how much you're willing to spend on the tower.

Expanding a little bit more on the size and the uses and the cost, this slide shows that for onsite power, remote power without a grid, that most of these systems are under ten kilowatts. So again, if you think about a water pump for your house, it would probably need about a one-kilowatt wind turbine. The house itself might need maybe five kilowatts to supply all the power needed in a reasonable wind resource. And a farm might need ten kilowatts. So when we think about remote communities, internationally remote communities or small farms, we're thinking typically less than ten kilowatts.

You do see remote communities in Alaska obviously that are hundreds of kilowatts, and they're not connected to a national grid, but they do form a micro-grid. So what we're talking about here with remote power is off-grid systems that are for a specific use. And the cost of these things, for the wind turbine only ranges from around $6 a watt to around $12 a watt or so. So a one-kilowatt system installed might cost you $6,000, or a ten-kilowatt system could even cost you all the way up to $120,000. And a grid-connected system, which could be a residence is often going to run a little bit cheaper because it just does. It's simpler. It has a different controller in some cases. And we get different economies of scale. We don't see so many one-kilowatt on-grid systems I'd have to admit. And that $3.50 per watt is generally on the larger end of the system scale.

The midsize units have a similar cost span that you see there. Convenience stores are typically in the fifty kilowatt space and schools are around 250 kilowatts, just for a sense of scale again. And these utility scale projects are running in the $2-to-$3 per kilowatt space.

The cost for a wind project, when I give you that range, varies. It depends on the topography, like do you have to drive up the hill to put the turbine in, so do you need to make a road? If it's a large wind project, is that collection grid going to be running along a ridge top or is it going to be out in a flat field? Is there any clearing required? How much real estate needs to be patched together to make a project? That can increase the cost. And again, this is illustrative, not comprehensive.

The design itself for the grid collection system. What sort of environmental hurdles you may run into. For example, if you have an avian species you're worried about, you may have a pre-construction monitoring interval that could be a couple of years long, and that could be very expensive. In other places there are no avian species that you're worried about, and things can go through fairly quickly.

Weather delays. So if you're in an area where you have difficult weather, or soil conditions that can be difficult to work in when it gets wet. Other areas, let's say in the Caprock of Texas, it can rain and it's not such an issue. Other places in Texas if it rains, that caliche turns to concrete and you can get stuck forever. So those kinds of things can definitely ramp the cost up. Again, the total installed cost for utility projects tend to run these days in the $2 million per megawatt, or the $2 per watt space.

This slide is a nice depiction from the 2010 wind market report out of Lawrence Berkeley National Laboratory. It's a nice depiction of the cost of wind per kilowatt installed over a period of time and across, and even within a specific year. So you can see that over the past thirty years the project costs have come down considerably. What's not as apparent in here is that the productivity of the project has gone up considerably. But you can see that if you look in the 2011 figures, that there's a pretty big spread, and we're all the way down to $1,500 per kilowatt, or a million and a half per megawatt, and all the way up to $4,500 per kilowatt, or $4.5 million per megawatt.

And that again, thinking about the previous slide, that's a function of how complicated the build is. And it's also a function of what the competing busbar cost is to justify that. The blue bars represent the average weighted cost for projects, and you can see that that is ringing in at least for 2011 right at $2,000 a kilowatt.

So one question as you consider wind energy and are approached by various folks perhaps trying to sell a wind turbine or even a concept is, how do I know if it's the right turbine for me? How do I know if it's going to be a good project? And again, not to be comprehensive, but there are a few questions that you can ask right out of the gate that will give you a sense of whether it's the right turbine for you. The first thing is, has anybody heard of the turbine before? Or is this a brand new prototype that nobody's ever seen? If it's a recognized brand, it may be certified or listed by somebody out there. And somebody, a body would be like the Small Wind Certification Council, or Underwriters Laboratory. So the Small Wind Certification Council will actually test small turbines for performance, safety, and durability, and Underwriters Laboratory, or UL, you may have seen that on your coffeepot, is what would test it for electrical compliance for interconnection with the utility grid.

Now the Small Wind Certification Council has not been around for very long so there's not very many certified small wind turbines, but there's a lot of certified large wind turbines because large wind turbine manufacturers cannot get financing unless they're type certified.

For those small turbines that are not certified, it's another mark to tell whether they're real, is if a third party group has tested them as to verify that, in fact, the manufacturer's claims for performance or reliability are true. So if you can find published data, or somebody can bring that to you that was collected by a third party organization, that would give you a sense of comfort.

And finally, there are state organizations, incentive organizations, such as the New York State Energy Research and Development Authority, or the California Energy Commission, who have invested lots of money in supporting small wind energy, and they have lists of approved vendors, because they know which turbines have delivered in the past, and which are likely to deliver in the future. They can get uncomfortable with other people using their lists, because they don't want to be responsible necessarily for recommending things. So you cannot look at another agency's approved equipment list and see it as approval for your own, but it's a good indicator.

And finally, another question is, how many units have been installed in the U.S.? So there may be 1,000 or 10,000 units installed in Mongolia. Does that mean that it's a good option for an installation in Alaska? Maybe, maybe not. Because if there's no turbines installed in the U.S., it's unlikely that there'll be a domestic service organization in place, or there's going to be access to spare parts. And those kinds of elements can really, really reduce your uptime and leave you with a very nice lawn ornament for a long period of time while you wait for repairs. So understanding if there's a domestic service organization in place, and better yet, a local service organization so that you can know that you'll have maximum uptime.

And then finally, there's a number of units out there that are reconditioned. There's turbines that are coming down out of California wind farms from the '80s that some machine shops are rebuilding. And not all refurbishment shops are created equal. So it's very important to understand the reputation of the service shop that is refurbishing a turbine before purchasing a machine from them.

So speaking about refurbished wind turbines, this is a nice project example of the Lakota Nation up in the Dakotas where they installed a refurbished wind turbine at the local radio station. And in this specific case, to make sure that they had local service providers onsite and handy, they trained their own tribal members on the turbine maintenance. And because they're able to take this project, which was a multi-year project, I think it took about five years for them to get it together, they had a lot of stakeholders involved, including the maintenance staff. And anytime you have a project that takes a certain amount of time to pull together and people to rally around it, you end up with this really nice beacon about environmental stewardship and forward thinking that can serve as a great example for other folks in the area.

And of course, benefits include not just the energy savings, the cost savings, and the levelized energy costs going out, but it's also the opportunity for the tribe to demonstrate environmental stewardship, to really walk the talk. And finally, when you can train up your own tribal staff on turbine maintenance, now you have folks who'll have skills that are valuable elsewhere. So many benefits come out of these projects that are beyond just the electricity generated.

So thinking about ancillary benefits, benefits in addition to the electricity, what often comes up is the carbon dioxide savings, and reduced water use. So when we're thinking about how do we improve our ability to be good stewards of our environment and how does wind fit into that, it is valuable to acknowledge the fact that by not generating power with fossil fuel energy, we are offsetting carbon emissions. And those offsets are dependent on the blend that we are offsetting. So that blend is different in different parts of the country.

So you can see that in Nebraska, for example, which is a reasonably large coal state, our offsets are maximized, whereas in Tennessee which has a little bit more nuclear, our offsets are diminished somewhat but they're still substantial. And this is on a per-megawatt basis. So for each megawatt in Tennessee you're offsetting 2.4 million tons of CO_2 per year, and for each megawatt each year in Tennessee you're offsetting 1.3 billion gallons of water usage. So the environmental benefits for wind can be substantial.

So now that we've talked a little bit about the resource map and the technology and a project example, I want to dig in a little bit into what policies are important for project development. On the Federal perspective, there are many incentives that work really well for taxpaying entities. And this is a problem for non-taxpaying entities. We see this for not just tribes, but also municipalities, state organizations, nonprofits, schools, colleges. And these sorts of folks are often curious about well, how do we access these incentives?

In the past couple of years the incentives on the Federal side included the accelerated depreciation, and they included investment tax credit, which could be leveraged as a grant. And these things together could equal 30% or 40% of the total project cost. That's substantial. And it's an enormous savings that were not available to many people who wanted to invest in wind energy.

The good news is, is that there are business models out there, and there's financing structures that allow you to access these great incentives. So just because you're a tribe doesn't mean that you can't find the right business model and the right equity partner that will allow you to leverage these important incentives.

So the production tax credit, which is the principle Federal incentive that's been around for a very long time but has also lapsed in past years and looks to be lapsing again at this point, it's scheduled to lapse at the end of 2012, is an important incentive and represents in many cases a significant fraction of the revenue from a project. The Farm Bill, which is the USDA REAP program, the Renewable Energy for America program, provides grants of up to 25% tapped at $500,000 for renewable projects. And it was for farmers and ranchers, and rural small businesses. Well the good news is there, is that you can create a rural small business with another equity partner perhaps and access that sort of incentive program.

From a permitting perspective, when you access Federal dollars you also trigger the National Environmental Policy Act, and all the things that come along with it, and NEPA has requirements that include the fish and wildlife reviews, and these reviews can be complicated and lengthy, and require certain investment with consultants on the biological side. And it also can trigger historical preservation elements, and not just state historical, but tribal historical perspectives as well. So that's very important to understand and appreciate what that means in terms of project timing, and project cost.

Similar to the Federal incentives that can require certain partnerships in order to leverage them, many state incentives also require these sorts of arrangements in order to access them. There are state renewable energy portfolio standards, for sure. There's twenty-nine states that currently have those, plus a number of others that have goals which aren't quite as strong, but they're out there. There's state grants, and rebates, tax incentives, and others. Again, it takes a creative business arrangement to access these types of incentives for a tribe.

So the Department of Energy and the National Renewable Energy Lab have provided outreach support for tribes for a number of years, but historically we did provide support to the Native American Wind Interest Group. We had a number of success stories, and direct technical support that we provided through that organization. We've provided technical assistance both in terms of anemometer loan programs, and also in terms of doing feasibility studies for tribes. We put together training videos, and even a wind energy application training symposium is something that we've held over the years where we've brought in tribal members from around the country and brought them into a single room and provided two to three days of wind fundamental training.

All these elements are available upon request, especially when funding is there. So it's important to know that if you are looking for this type of support from the Department of Energy and the National Renewable Energy Laboratory, that you ask for it and help out in figuring out where the costs are going to be covered from.

So what we've covered is an overview on the resource, where it is in the country, what it looks like. We talked a little bit about the technology and the scales, where you can put it, where you shouldn't put it perhaps. What it costs. How much it makes. We gave you a project example. We talked a little bit about some policies that are relevant to project development. And I'd like to spend the next slide talking a little bit about additional information and resources.

So these are a few additional resources – again, not comprehensive – for you to dabble in. The first one is the Wind Powering America, a Native American website or link. And here you can access a host of our historic activities in this area.

WindPoweringAmerica.gov website is our main web landing page for our program, and provides access to the maps to the historic installations across the country. Into much deeper discussions about siting, and about public acceptance. Environmental considerations. And even educational and workforce development elements.

On the technology side, I've given you a couple of links. One is for the National Wind Technology Center, and what sort of research we're doing here. But I've also provided you with a direct link to the Small Wind Certification organization. And there's some fantastic discussions there about what makes a good small turbine a good small turbine.

And finally, on the policy section, there's what should be a familiar link for you to the database for state incentives for renewable energy. And this is the go-to location for all policy elements within the United States.

I'd like to thank you for your attention and provide you with my contact information if you should have any questions in the future. This was a very high level and fairly brief overview of wind energy technology, and I'm sure you appreciate that it's very difficult to bring you completely up to speed in a brief half hour or so. So do please feel free to reach out if you have additional questions.

Operator:
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 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 renewables 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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