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

Below is the text version of the webinar titled "DOE Office of Indian Energy Foundational Courses Renewable Energy Technologies: Assessing Energy Resources".

Amy Hollander:
Hello. I'm Amy Hollander with the National Renewable Energy Laboratory. Welcome to today's Webinar on assessing energy needs and resources 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 brand new state of the art net zero energy research support facility in Golden, Colorado. Our energy needs and resources presentation today is one of nine foundational Webinars in a series from the DOE's Office of Indian Energy Education Initiative designed to assist tribes with energy planning and development.

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.

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 then 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, Nate Blair. Mr. Nate Blair is a Group Manager for the Data Analysis and Visualization Group and the Energy Forecasting and Modeling Group at the National Renewable Energy Laboratory known as NREL. Mr. Blair has been at NREL for ten years, and has been developing renewable energy and efficiency system modeling for 20 years. He has worked on tools such as TRNSYS, ReEDS, winDS, SAM, PVWatts and other commonly-used resource tools.

Mr. Blair has an MBA and an MS in Mechanical Engineering from the University of Wisconsin-Madison, and a BA in Physics from Gustavus Adolphus College.

Nate Blair:
Thank you for that introduction. I'm Nate Blair and I'm happy to be here today. We're going to talk about a number of different issues related to renewable energy resources, and then followed up by a number of tools that we use to help industry and various other audiences access renewable energy and information about renewable energy for their own situations.

So I'd like to start with this slide. Our group here at NREL does a lot of the geospatial work that NREL does, particularly with regards to mapmaking. This is something we've been doing for a long time.

As you can see, we've done in the past a variety of different maps related particularly with regards to tribal lands, both wind on the right, and in the lower left is potential PV generation from tribal lands, and then we have a lot of general non-tribal maps as well, and they're all available at our GIS website and through our map search tool.

One of the things that we do at NREL is we look at the resource characterization and technical potential, and in a timely plug I will also announce also that we just recently released our new technical potential report for the entire country that lists the technical potential by state for a number of different technologies, but this slide shows how we do it, basically.

So we start with the underlying resource, which is basically how much sun hits the ground, how much wind blows overhead, how hot the ground is underneath for geothermal energy, and then we start looking at, well, can you build something there or not? So obviously you don't want to build a PV system in the middle of a lake so we start removing exclusion areas, urban areas, water features, wetlands, and again, depending on the technology, we remove things differently. We look at slope in contiguous area. Slope is particularly important for large, flat technologies like CSP.

And then we look at is this an area where there's a lot of endangered species or a number of issues with wildlife or fauna or is it federally protected, and we get down here to the bottom left of the slide, where we get to watch the generation potential for that particular area, and then in our report we've added that all together to go to the state level. We sometimes do this for particular regions. We could do this for particular tribal areas, and have done that in the past.

And now I'm going to go through several slides that look at the resource potential for various technologies just to kind of give everyone a good rule of thumb as to what these technologies can do and where you're most likely to see them used in the country.

So this first slide talks about PV or solar panels, or photovoltaic or however you want to call it, solar resource, and as you can see, a lot of the country is in yellow, and that's probably a place where you might see PV so you can see it all over, and as you can see, it's particularly sunnier in the Southwestern U.S. In the Northwest by Seattle, as you would expect, it's not nearly as sunny, and so the resource goes down. Alaska has a lower resource and Hawaii has a higher resource, but if you were to compare this with, say, Germany, most of their resource is more in the blue area closer to Alaska, but they still have deployed a large amount of solar panels, U.S. concentrated solar resource.

So this is very much like the solar panel resource, but as you can see, it drops off more quickly as you move out of the southwest, meaning that it's less likely that you would see any concentrating solar power outside the southwest because these mirrors and reflectors can only use direct radiation. They can't use any kind of diffuse. So if it's humid or there are a lot of clouds in the sky and it's hazy, they don't work as well.

Next slide is wind resource, and this is really to show that there are a couple of really great areas of wind resource in the country, and as you can see, purple being particularly great. A few areas really stand out. Pretty much anywhere in the Midwest, all the way from North Dakota down through Texas, and that continues on into Canada, are really great resource areas for wind power.

Another great resource area is off the East Coast, offshore. Offshore wind costs currently more than onshore wind, so we haven't seen a lot of it developed, and in the Great Lakes and then on the West Coast. Now the West Coast has significantly deeper water, which also impacts the cost of offshore wind.

But I think what you're seeing is a lot of wind development in the Midwest already, and particularly in Iowa, for example, and North and South Dakota and Wyoming, but one of the problems, of course, is that the windy areas aren't often close to where the people live. So that's why offshore is becoming more interesting.

The next slide talks about the biomass, and here you can see that there's biomass resource throughout much of the country. Again, in the upper Midwest there's a large amount of biomass resource. I think the important things to note are what type of biomass resource are you talking about. You can see here there are a number of feedstock categories listed, dedicated energy crops, egg residue, wood residue and municipal discards they call it – landfill methane, domestic wastewater treatment – and these feedstocks are what's contained here. I think that, as you can see, there's quite a bit on the West Coast, quite a bit on the East Coast, and then in the upper Midwest. The West generally is not a great resource for biomass. The Southeast is a pretty good resource for biomass, and of the typical renewable energy resources, that's the one that a lot of people in the Southeast focus upon.

One other thing about biomass resources, that it is subject to the marketplace. So as we've seen with corn ethanol and other technologies, if there is a growing market for, say, dedicated energy crops, then you would likely see more of that planted and more of it harvested. So unlike solar and wind, this map is actually subject to market forces.

Geothermal resources are a little harder to deal with in some sense because you can't see them. Right? So they're all underground. This map really combines two types of resource. The black dots have to do with potential hydrothermal sites. So these are sites where there's actually potential for hot water under the ground, which you can access via a borehole. However, the colors part of the map deals more with what they call enhanced geothermal systems or EGS systems, and the idea with an EGS system is that you can drill a hole deep enough, and so it's probably several kilometers, three to five kilometers deep, and inject cold fluid in one side. The fluid heats up and comes up a second borehole on the other side, and is warm enough at that point to power a steam turbine.

And so there aren't a great many EGS systems built yet, but that's some big area of study for the DOE geothermal program.

So we've talked about the different resources and where they likely are in the U.S., and I'll just summarize that section by making a plug again for map search tool. At the end of this Webinar there are a list of resources that you can get to on the web, and if you can't find the right piece of information, there's a place to provide feedback on that system as well, and see if we have, perhaps, additional maps that aren't included on our online presence.

Next I'm going to talk about applications, and these expand naturally from the resource maps in the sense that many of these applications are built upon the underlying resource data, and so they take it to the next step, looking at what would be the performance of a renewable energy system at a particular site or what would be the economics of a renewable energy system at a particular location. And we have several other tools that are sort of looking at additional market forces that I just would like to point out.

So we'll start with PVWatts. PVWatts has been around for slightly over a decade now, and it gives you a great first cut at the potential performance of a solar panel or a PV system either on your house or residence, or even at a larger scale for an entire community. It is very simple in the sense that it only requires, if you look in the lower-left part of the slide, about five inputs, and from that it generates a monthly and annual, and in some cases, depending on the underlying weather data, an hourly set of information and outputs that give you an idea of what the performance of a system would be.

Now when you install a system there are issues around soiling and whether you're keeping it clean and whether you have a lot of snow cover, et cetera, that can move the actual amount away from the predicted amount, but this will get you pretty close. It's used a lot. It's probably consistently one of the top five most visited websites at NREL.

So we've taken PVWatts, which just gives you a performance estimate, and now the question is, well, but does it pay off? Is it a good investment? So we want to take it to the next level, and we've done that with yet an additional simple tool called IMBY or In My Backyard, and the IMBY tool allows you to zoom in, using Google Maps, to your rooftop, and then once you are at your roof you can draw a box around your roof and it will say, "Hey, on your roof you can fit, say, six kilowatts of PV, and our typical price for PV is X today," and the user can change all those values. And then it will tell you here's what the simple payback would be for your system. Here's what the cost of energy would be for your system, and if that looks good to you, then the vision is that the next step would be you would go and talk with a local PV installer. And so those are two tools – PVWatts IMBY – that allow you to get a great first cut at photovoltaic systems, and then performance and cost effectiveness.

The last tool that we typically think about, especially in terms of solar panels, but also in terms of a number of other technologies is our more complex tool called SAM, which stands for the System Advisor Model. It's a freely downloadable desktop tool. It is not as simple to use as PVWatts or IMBY, but it has a great deal more capability. For example, on the PV side it can pick a particular PV panel. You can pick a particular inverter. You can lay out your system in more detail, and it allows you to do a great deal more complex analysis and cash flow. SAM is the only tool available that allows you to do a detailed performance model, and pair that with a detailed cash flow model. It's been around for a number of years, and it's used by developers, manufacturers, solar installers, consultants, analysts and students here at NREL, and at other laboratories and universities.

In SAM we represent predominately solar technologies, but in the last couple years we've also been adding in some other technologies. So we have flat plate photovoltaics or typical solar panels that you would think of. We have concentrating PV, which chooses a mirror to focus the light on a very small solar panel in and attempt to save money that way, but then it has to track the sun throughout the day. So that's a concentrating PV, solar water heating, and then we have a number of concentrating solar power thermal technologies – parabolic troughs, power towers, Linear Fresnel and Dish Stirling, and then as I was saying, we've added a couple of technologies recently. In the upper-right-hand corner is geothermal power. We currently do not include geothermal heat pumps, which is a typical question that we get because we do not model buildings in great detail, and then in the lower-left corner we've been working on wind technologies – utility-scale wind as well as turbines that are appropriate for small-scale wind.

And then lastly, bio power is a new technology that we've also added, and in all these cases we typically will go to our resource here at NREL, so that's the wind resource files, the solar resource files, the bio power feedstock databases, and grab that data across the Internet to run the models with the appropriate localized data. So that's one of the nice ties between the SAM model and our resource data.

Basically, as I was saying before, we take two pieces: We take the system at the top to do a detailed performance calculation. So we take all the system specifications, which in some cases is hundreds of inputs, but we have defaults for all of them, and then we add in the local weather data, and that gives you the hourly, or in some cases even sub-hourly electricity production. We combine that then with the cost data, which you can change, but for which we also have defaults. We have the ability to look up local utility rates, which I'll talk more about in a minute, and incentives, and we include financing details, and we do a cash flow analysis for the entire life of the project, and we end up with a lot of these sort of performance/economic metrics. So our key metric is the levelized cost of energy, which is something that you can compare to your electricity rate, especially if you're looking at a residential system or commercial system. So this will be in cents per kilowatt hour.

Then the net present value is how much you're either saving or losing over the lifetime of the project all brought back to the present; payback, how many years will it take to pay back to the system. What's the revenue? What's the capacity factor of the system?

What are all the performance parameters, and you can dig into it in greater depth if you like.

So the CREST model is like the SAM model, except that we've thrown away all the detailed performance calculation. So for people that really want to look at the financial piece and dig into that, the CREST model is an Excel-based model, which a number of people prefer to the SAM model because they like to dig into the equations in the Excel. For CREST you just put in what's the nameplate capacity and the efficiency. You don't model a system in detail. That can be really great in some cases because you don't have a lot of details about the technology like you would need, perhaps, for SAM, and so what CREST allows you to do is look at a number of different scenarios on the financial side, and it's been developed in conjunction with state incentive developers to try and meet their needs. So that answering the question of, well, what kind of incentive would we have to give people to create a market for, say, small-scale wind? So that's a relatively recent tool developed here by our finance team.

This tool, Open PV, is one of several tools and databases that NREL has developed and is ongoing in development to capture information about the installed market. So one would think it would be fairly easy to figure out how many PV systems have been installed and where they've been installed. Well, a couple years ago we realized that nobody really knows, and so with the support of the Department of Energy Solar Program, we launched the Open PV tracking tool, which allows you to upload your information about your own PV system, but also we go around to all the state subsidy providers and installers and try to get them to put information in about all the systems that they know about in an attempt to capture all of the systems that have been installed in the country. And I think that we are up to probably 80 percent, roughly, of the systems that have been installed. Anyone can come here and install their own system.

And I think the interesting thing from a travel perspective is, if you look here on Slide 22, you are allowed to zoom in to a particular county and see what we have in the database in terms of – actually you can zoom down to a particular ZIP code if you'd like. At the county level we often have a fair amount of data looking at how many systems have been installed, what size were they, when were they put in and what did they cost, and so if you can zoom into your county or your ZIP code and say, "Hey, there's a bunch of systems being put in, and it costs this, and geez, I'm getting quoted something that's quite a bit higher or quite a bit lower, why is that?" And you can look at the difference in cost by system size. Obviously, larger systems will typically be cheaper per kilowatt. So this is a great tool. It's lots of fun to explore.

The solar prospector is one of several tools, and I'm not going to highlight all the other ones, but we have now a geothermal prospector. We are developing a wind prospector that will come out in the fall of 2012. The solar prospector has been around for several years, and it's really a way that we can deliver detailed information about the solar resource and particular pieces of land to the industry. So the idea is that they can click on a spot here and get some idea about what the solar resource looks like, how variable is it over the year. You can download data from 1998 through 2009. We've got a variety of different little analysis capabilities, and the idea is to help the industry effectively and quickly figure out the feasibility of a particular location.

Data challenges and solutions information sharing. So we've got a number of tools that I would like to alert you to that can help you in a more general way than these particular models that I've been talking about. One of these tools is OpenEnergyInformation.org or we call it OpenEI. It's a growing source of energy information contributed by a variety of stakeholders. One person once described it to me as the Wikipedia of energy information, and so we've been working on it now for several years, and we continue to work on it. We're getting a number of groups and organizations that are adding data to it. The nice thing about it is that all the data that gets added is what they call linked data, and so that you can more easily draw connections between these different data pieces.

For example, on this particular slide, in the lower-right corner you see the State of Kentucky's energy resources, and so as a map of Kentucky it talks about Kentucky, and then further down on the page it actually shows all the technical potential data that we recently added from the report that the geospatial team just produced. So there's a lot of information here. It's OpenEI.org. They've just updated the search and the datasets so it's worth visiting.

The real problem is that utilities don't produce their data in a consistent framework across all utilities, and they don't provide their rate data in a machine-readable format, and so to do analysis and to do SAM analysis or other types of analyses across a number of different locations is very difficult because you have to go to the utility page. You have to pull down a PDF of their utility rate and extract the data, and it's easy to get it wrong as well.

So you can get the average retail price from the U.S. Energy Information Agency, but that doesn't give you any of the real details of the utility rate, and the utility rates themselves are quite complex. The solution is that on the OpenEI platform we have a created a utility rate database. It's completely web based. We have over 23,000 rates now. Illinois State University is working with us to populate the database under contract from the Department of Energy, and we've got a lot of different types of complex utility rates that are in here. If the utility wants to pay you more in the evening or more in the middle of the summer day, then PV or solar panels will probably look better to you than they would if you just assume a flat rate. So we have over one-thousand utilities represented, with well over 80 percent of the U.S. load served residential/commercial rates, and then tools like SAM or other tools can access this utility rate database as well, and so a number of tools are starting to access the database.

Figuring out what renewable energy technologies cost today in the marketplace is actually more difficult than it sounds. It is particularly difficult for utility scale systems. You cannot go and buy them at the Apple store like an iPod so it's difficult to know what a 100 megawatt PV system will cost you, and much of the information is held in confidence by both the utilities and the developers, but we have at NREL taken a stab at collecting all of publicly-available cost area that's out there, and providing it via this new web tool called the Transparent Cost Database.

Not only does it include electrical generation technologies, like wind and solar and geothermal like we've been talking about, but it also includes vehicles, EVs and biofuels and a variety of different fuel types, and it presents it all in a drilled down tool that allows you to maybe look at the average value, but also look at the detailed values, and this is a brand new tool that just came out here in the summer of 2012, and is going to be updated robustly over time, and I think we'll be able to provide the community with a good source of information about what kind of typical national average values are for these technologies. This can be useful if you are in negotiations with one or more developers. You can say, "Hey, look, I'm getting these numbers. Are you cognizant of these cost numbers? Why are you so much higher or lower?"

We often get the question at NREL and within the renewable energy community, how many jobs does a particular solar plant or wind farm create for a local community, and in some cases a wind farm can create a number of construction jobs while the wind farm is being created, and then several varieties of long-term jobs for maintenance and monitoring while the plant is in operation, and so different technologies create different jobs, and we work with an economic data provider and create this tool called the JEDI tool, Jobs and Economic Development. It has absolutely nothing to do with *Star Wars.*

The JEDI tool has been around as a spreadsheet for a number of years. We have just recently released the PV various or the photovoltaic version of the JEDI tool as a web tool, and so we hope that the other spreadsheets will also follow and become web tools as well, but you can use it either as a spreadsheet or as a web tool, and you just need to put in these locations of the proposed system and then some details about the systems, and then it provides for you, if you look in the lower left here, in this case 14.8 jobs in total, and in construction and installation is 5.8, and the related services to construction is nine, and then I think a couple of more long-term impacts as well. So this is really great if you're trying to look at what the economic impact of a new plant would be.

That's the end of talking about applications, as well as data challenges and solutions. I'll end with this last link to all of the tools, all the tools that I've talked about today, plus a number of other tools are located at these links. I'll just mention on the top the applications that are geospatial, so map apps. You should just go to maps.NREL.gov to look for those. Map search if you want to look at some of the maps that I talked about today. Those are at that second link. RE Atlas is the third link, and that looks across all the different resources that are available and allows you to drill down into those, and then that last one, OpenEI, which I talked about as well is the second one from the bottom here, but all of these are interesting tools to play around with and explore.

These are the links that I was just talking about also divided into three categories; the top category being resource. So that's if you want to just look and dive into how sunny is it and where is it sunny. Technology adds in the technology performance and some of the economics pieces that we've talked about, and lastly, policy which looks at some of the implications of utility rates and cost, as well a sort of the general OpenEI framework, which has a variety of different information pieces.

Thank you very much. My name is Nate Blair, and I am available if you'd like to email me for additional information.

Amy Hollander:
Thank you, Mr. Blair, for that excellent overview of energy needs and resources and the numerous tools developed by the Strategic Energy Analysis Center at NREL.

There are three series in the program: the Leadership Series, the Professional Series and the Foundational courses. The two columns here demonstrate how both the Leadership and Professional Series have project development and project financing modules delivered in person and some through webinars. The foundational courses offer energy basics and renewable energy technologies, as listed on the next slide.

All of these Webinars can be found at the DOE Office of Indian Energy website. With that, I want to thank you for your attendance. If you have any other questions for our speaker today, you can email Mr. Hunsberger after the Webinar at Randy.Hunsberger@nrel.gov.

Thank you, and be sure to visit the DOE Office of Indian Energy webpage for future postings of Webinars and other tools.

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