USE OF PREDICTED VS. MEASURED WIND SPEEDS IN THE DISTRIBUTED WIND SECTOR

July 12, 2012

Coordinator: Welcome and thank you for standing by. At this time all participants will be in a listen only mode until the question and answer session. To ask a question at that time, please press star one.

Today's conference is being recorded. If you have any objections you may disconnect at this time. I would now like to turn the call over to Karin Sinclair. You may begin.

Karin Sinclair: Hi. Thanks everybody for joining us in this webinar in the (unintelligible) series of bimonthly webinars. And we have - you can see what the title of the presentation is up on the screen.

We have Cullen Kasunic, here today to give us a presentation on - to give us a presentation on just some pools that they have used or developed to help differentiate between predicted and major wind speeds. And also to tell us a little bit about the model itself.

So Cullen has been involved with emerging technology for over 15 years. And he has been working in that area of wind for the last three years. And he's the Vice President of Wind Analytics. And so I am just going to turn it over to Cullen.

Cullen Kasunic: Good afternoon guys - good morning. My name is Cullen I have worked with Wind Analytics for a few years here. And what I want to talk about today is the importance of resource assessment and improving resource assessment in distributed wind source projects which are really small medium community scale projects.

I have a little more introduction to do as we go on. But really what I wanted to do is walk through different aspects of what we have done. And some tests that we have done, so.

Let's see, to do this I'll give a brief overview of my background and our company - of our process and some validation and testing we have done on our process. One thing I want to mention in regards to talking about our process - I think it is a good way to highlight just different things that are important to consider and look at in doing a wind assessment. And in resource assessment overall.

We do have some validation on our process. And what ties to that is we took some of that information and have looked at some different possible performance outcomes based on variations in wind resource estimates. Then of course we have some time for Q&A, so.

Is there anything else on your guys side Karin? Or shall I continue on?

Karin Sinclair: No. Just go ahead.

Cullen Kasunic: Alright.

So, briefly we are a company based in Brooklyn, New York. We do wind analysis. We are focused only on small and medium scale wind really behind the meter wind analysis projects. Founded about four years ago. We have got a lot of R&D funding from (unintelligible). If you guys are familiar with (unintelligible) and the work that they do.

And what we did with that funding and the funding that we have put together was the overtime develop of micro scale wind analysis toolkit. Something that really allows us to look at what wind is doing at a given location. So unlike a wind map that might give you a broad overview of what is happening. This is really targeted at getting a specific sense of what is happening at a location.

Also targeted with the needs of small and medium wind in mind. Given that a lot of projects - it would kind of kill the viability of the project if assessment or really any of the other components cost too much money or took too much time. So we designed this system to be well fit with the cost and time constraints of distributed wind.

It was built with an experienced science team. I was involved in coordinating the process but the Chief Science Officer (Sandra Burton) was deeply involved. He's a gentleman out of (unintelligible) and has written on the subject of small community wind issues.

And then also we were partnered with a company engineering firm out of Canada that is well known for doing studies on wind energy as it interacts with objects. And they are a big firm out of Canada. And between (Sandra) and (unintelligible) we built our wind analysis methodology. And it has been refined as we have gone on. So I will talk a bit about our process here.

Really it can be broken down into three stages. Understanding the location, pulling in the appropriate data and then determining what the turbine will produce. So this is kind of a standard thing for any type of wind resource assessment.

The way that it works is one can look at different study points. The way that we do it in our system is that we have a property line and we have various

points where you can look at - these are essentially hypothetical turbines. You can see by putting the point down and assigning what the wind energy will be like at that location.

The next step is to classify the land cover. What we do to understand what the wind is going to be like is we understand part of it - is we understand what the surrounding land cover is. This is what people may do by applying shear factors while taking that many steps further by looking in multiple directions. And using our own land to cover types.

To classifying the land cover around the site is critical to those interactions to distances. And we are looking at about 1500 meter radius for the far field. 500 meter radius for the near field. From our science and our studies have shown that is - those are relevant distances to look at and consider.

There is actually an additional distance that we look at though it is weighted a little bit less. And that goes out to five kilometers. So, different distances have different weights. And that's something that you can consider in doing this assessment.

Let's see. So, we do have ten (unintelligible) covered types. But we have determined through working that assigning a single land covered type to a single factor does not result in the most accurate estimate. So what we do is we do a weighted average of different land cover types within each sector.

So as you can see here there is - in that near field sector right near the turbine up at the top there is some forest. There is some open countryside. And then there is also a silo which we would call urban. And you can see in the far field it is a little different. There is water, grassland and forest as well. So, in doing

that we arrive at the predominant land cover for that section which has its own factors associated with it.

And we can do this using GIS tools. This is just a quick example of how we can do it in one (unintelligible). We use an image tool call pictometry. And we can draw some polygons around different land cover types and get a sense of what the area is within those polygons.

The next thing is to understand and identify nearby obstructions. Obstructions can have a huge impact on the wind. They can sometimes take away all of the wind energy from a given direction. And if that is one of your prevailing objections that can have a huge, huge impact on your wind resource of course.

So, characterizing and classifying these obstructions is an important thing. And we have built our own system to look at different distances so that we can draw these obstructions in and our system will calculate obstruction impact. Essentially how much energy is lost from that direction based on an obstruction of a given distance and height.

And those readings just help to see what is the relevant height. Because, obviously you can't spend time drawing in everything, so some things must be relevant. And other must not. So we have built a baseline set of distance rings to help determine what is relevant. Okay.

And just looking at it another way - sort of a clear diagram. But any obstruction that is going to affect the turbine is going to cause a wake and that wake will be a certain distance. And a certain height. And the size and shape of the wake is dependent on that distance and height and the width of the obstruction as well. So you can see that right there.

And using certain tools, there is actually some really cool tools out there to check out for doing things remotely. Our whole process is done remotely. And it is done with existing met-data. We are not gathering any met-data. It's all done using existing met-data remotely.

And what we use to measure heights very often is a tool call pictometry which is a bleak air image that lets you look at a given location and it actually allows you to measure the heights of obstacles among other things so that is something we use it for.

So now if there is any questions, I think it would be a good idea for me to stop several times through here if anybody has any questions we can address them as we go. And so, if there are any now, I will pause and answer. Otherwise we will continue.

Coordinator: To ask a question please press star one. You may withdraw your question by pressing star two. Once again to ask a question press star one. Just one moment.

And there are no questions at this time.

Cullen Kasunic: Okay, nothing yet. Well, really what we are looking at is two halves of this wind analysis process. The first half is gathering the local project information. The next half is understanding which data should be used. And we have developed a data set based on (unintelligible) data. This is a national and global coverage of net stations with long data history. Many have - many, many years of data. At most we work up to 1976. We do some adjustments to work that far back. But we don't like to work back further than that.

So many stations we are working with here. We can be working with that 37 years of data. And you can see here this is a coverage map of the US. The blue areas are areas where we have kind of standard certainty. This is where we feel most confident doing a study. And there are some areas where our certainty - our confidence is reduced. And these are particularly remote areas. Montana, Nevada, Alaska, et cetera.

So, what we're doing now is selecting met stations. And we have taken all of these (unintelligible) stations and we have processed the data and cleaned it and done some things to it so we can work with it given our methodology. And we have - first of all classified all of the stations based on the amount of data we have and the length of time it covers. So, really just a start and end date and then how much data is in between there. So that is the main part of how we classify data quality.

And when we are doing an analysis we select several stations and based on their data quality, we choose the best stations. And we also base some data quality on distance. So we do distance weighting to determine what the - how much of each station should contribute. You can think of this like we are triangulating here to understand and build a length profile around a given study location. This X here is the study location.

And just like land cover needed to be classified at the study location. Land cover also is classified at each of these meteorological stations that we have gone ahead and processed. So based on this processing we are able to go ahead and come up with the wind profile.

And you can see the way we do this here on this slide which is by taking each of these met stations and removing the impact of land cover the way that we - the way that I described before, to understand what the wind profile should be

like at geotropic height. Now geotropic height is of course the height above the earth where the surface friction of the earth no longer impacts it. So we are looking at completely smooth clean air. And there is an assumption that's rather valid that wind speed at geotropic height can be quite similar.

So, what we are doing is building this kind of composite aggregate wind speed profile up at geotropic height above all of these stations. Now, once we do that we can then triangulate them together right above the study area itself. And this gives us a study area wind speed also at geotropic height. And we are doing this interpretation by quality weighting of the data and by distance weighting of the data.

Now, this allows us to understand what the wind speed is at the study point. So, if we have created a profile now down at the ground level or at (unintelligible). So you can see here of the study points that we were looking at before - there are some significant differences.

Point one is the lowest. Point five is the highest. And these differences are really there because of some of the differences in land cover. Also differences in obstructions. We are talking about pretty much a small area with some pretty significant differences. So, really the cause for that is the obstructions. And this is a study that we have done before. And you can see.

Now, if you are familiar with how much wind speed will affect the production - this can have some serious impact on production. We will actually look at some of that later in this presentation. And that's what I want to spend a lot of time on actually - looking at that, so.

But just to talk through a little bit about how we calculate turbine production here. It's a pretty straight forward method. We are taking the wind distribution

which we have calculated for each site. We have calculated wind speed distribution. This chart here is energy distribution. It shows something a little bit different than what is going on under the hood but I think it is a little bit expressive of where all the energy is coming from.

But what we are doing is matching turbine power curves to wind speed bends as you can see here - power curve. And determining how much time the wind is blowing at each speed and then how much power we can generate from the turbine at those speeds. And then incorporating the time component to arrive at energy.

So, this one you can see here is an endurance system. And running all the numbers through the power curve there, we come up with about 150,000 kilowatt hours a year.

So, I think that's a good point to stop for questions again if there are any.

Coordinator: Thank you. To ask a question please press star one.

And there are no questions at this time.

And there are no questions sir.

Cullen Kasunic: Okay. No questions yet.

So, moving in to my - moving in to our final slide on testing. I want to talk some about studies that we have done regarding testing our methodology. We have done blind studies with eight different organizations. And these are studies where we have taken a (unintelligible) of a given turbine as well as equipment make and model of a study period. So we are really looking at

where is it and what tower height is it on. And what time. And we will look at what the wind speed should be there, what the wind profile should be there and what the turbine will produce.

We have done this with turbine developers and government agencies. So, what we found is that we have come to about a 17% average error. And in most cases we are underestimating the wind. And what this really means though is that, you know, we are trying to get the most accurate estimate of what's going on with the wind at the given location. That's what everyone is trying to do with wind resource assessment. And, you know, looking at the numbers here it looks like we have done well with that.

It's so important though to get an accurate number because of the fact that - if you think the wind is high you may invest when you shouldn't. And if you think the wind is low you may not invest when really it would be a great location for a winds turbine.

So we've worked with a lot of different companies to really see - is what we are doing - can it work. And, you know, it is still a testing process but it looks good.

I want to call this out as well which is that, you know, we feel a micro scale approach is very important regardless if you were to use a tool like ours. Or our - excuse me, contract with us. Or if you were to do your own analysis. Energy Trust of Oregon put out a study of estimated turbo production on the farm versus actual turbine production at some point later. And this was a kind of assessment or estimation program that they did where micro scale effects weren't really being taken into account.

Lands cover wasn't really being taken into account a part of a few other things being taken into account. And obstruction certainly won't be taken into account at the smaller scale. It was being done with wind resource map. And if you look in the bottom right hand corner there was some pretty significant differences between what the estimates were and what the actual were. And we really feel that was because, you know, for small and community wind - a wind map alone won't get you to the answer.

You need to really start to think about what the land cover is around. What the sheer is. If that is the way you are going to do it. And what the obstructions are nearby, so. We can - this was a very interesting study and we started working with the Energy Trust after this.

So, now what I would like to talk about is a larger study of our results that we did. And then relevantly could be the way that some of those results could fit into some hypothetical turbine production cases. So, thinking about what's the real situation at a location. And comparing turbine estimates versus turbine actual. And seeing what kinds of ranges there are and what types of ranges there can be. And really using that as a case study. I mean, I have gone through this - using that as a case study to see how important assessment is and how important it is that we all try to get more accurate on our wind assessment numbers. And how that can help the market, so.

What we did though was - as you saw in our model before, we had several airports that were being used to determine a wind profile at a given location. We decided to do a large but simplified study where we took one airport and used that as a source point. And another airport as a target point. So we used data from airport A to try to estimate what was happening at station - at airport B. And then we did it the other way.

We used data from station B to estimate what was happening at station A. So as you can see on the slide we did 244 of these trials at 86 airports. It was only part of our methodology. It only involves one airport at a time so to speak, because we are not using the triangulation. The way you can think of it is that our whole model is kind of the level of accuracy that you saw on the previous page.

This is one level of variability (unintelligible). There is a bit higher variability in here. And we can see on the next slide here - what we did first when comparing turbines is we said, okay - what are the actual of all of these airports. And we developed a baseline of what the typical airport was out of all of the 86 airports, what is the average speed and energy.

So now we worked with energy on this. All of our numbers that we talk about in terms of accuracy are on energy density. We find that it's a more relevant metric to speak about accuracy on because of course wind speed is only half of the picture when you are trying to determine what a turbine will produce. You also need to know the distribution.

But this other number - energy density is essentially wind speed applied to a distribution for just a given square meter of swept area. So, you will see that we use energy density here. And if you have any questions about that, we can discuss those towards the end.

So, we also chose three turbines here to look at so that we could see how much the variation would affect the output of these turbines. We chose an 11KW, a 50KW and a 275KW. And you can see some of the metrics down there.

So 3.97 meters per second was the median wind speed at the - at ten meters. Which is the height that this airport data is measured at. Well we did just for the purposes of comparison here, is we scaled them up - scaled the wind speeds up simply. This is not exactly - it's not at all the way that we would come to a real production estimate from our data. But what we wanted to do was to have some realistic wind speeds - reasonable wind speeds for these turbines and their tower heights.

So we just assumed that if it was 3.87 at ten meters and this was the energy density then scaled up these were the wind speeds. You will notice to that 3.87 meters per second is low to scale up to these wind speeds. That's because the energy density there and the distribution associated with that wind speed is such to cause the scale up to the higher. Okay.

So now we'll actually get into some of the results of the airport to airport tests. First of all, we compared all of these airports to each other. Next we came up with this aggregate -- what would a typical real system be. What would the real wind speed be. So this baseline here, we can call this the actual. This is made up of actual observed data from the 86 met stations.

Now, looking at the results from our airport to airport testing, we can come up with some ranges of how our estimates may come in. So, you can see here of our tests the mean arrow was 21%. That means that we were, on average throughout this study 21% under predicting. Standard deviation was 16%. And the error range was from 25% there-abouts overestimate to about 60% underestimate. Which is the 57% one. We also have (unintelligible) there.

As I mentioned these are energy density. And you can see the histogram here kind of forming a rough distribution. A rough normal distribution. But we haven't fit it to anything.

What we will do though is look at probability numbers for the low end of the spectrum and the high end of the spectrum. So, looking at this based on the standard deviation, the P90 number brings us down. And so we are looking at a somewhat less production for each of these systems. And the wind speed is lower of course.

The density went from 1031 to 874. Then we can look at the next one where we are now talking about 10% probability of exceedence. This means that around the high end of the wind - though the wind speeds are higher, turbine production is higher. And now our energy density underlying all this is about 1500 kilowatt hours per square meter per year.

So, before I move on I want to just underscore that we are looking at one scenario of medium variability here. Or what we could call medium variability. In reality when estimates can vary highly especially when obstructions are taken into account, you can have a very good estimate of the wind locally or regionally - let's call it semi locally.

But when you get down to the specific location an obstruction can really throw you off. So we are talking about typical medium range variability. So, before we talk about anything - larger amounts of variants - I wanted to talk about some factors that could decrease or increase the variants.

If you are working in simpler terrain that may cause the variants of any tool to be lower. This is true for our tool. This is true for a wind map. This is true for even when you are doing monitoring campaigns. In our case, a proximity to source data or wind maps case higher resolution data. If there is other reference data that can be utilized that may not be of the wind resource type you are using, that can help decrease the variants. And with wind maps, the

higher - they seem to be more relevant at taller heights because a lot of the surface do tend to break a lot of what is going on down there, so we have seen.

Of course factors that increase variants are the obstacles that I mentioned. If you are in an area where the land cover changes rapidly. Midwest, United States for example - land cover is not changing rapidly at all. You will have wide areas of consistent land cover. But, if you are in more of the northeast or other areas where you go from forest to field to suburb that can have some significant differences as well. Same as variable topography. And there are always micro-climates that can get you.

So, moving on we will look here at the higher variances of standard deviation gone up now from 16% to 28%. This is consistent with a wind map study that we did with these airports. And so our variation was 16% on the wind map. Our standard deviation was 16%. Wind map was 28%. And so we will go ahead with that and use that as a kind of a higher variance benchmark. And you can see here that at the low end, the speeds are even lower. And at the high end, the speeds are even higher. 705 kilowatt hours of energy speed versus - ranging from 705 to that 1700.

So, as a summary of all this data - you can see that there can be some pretty big variation in terms of the economic value that these estimates might suggest. So if you are looking at something that in reality will generate $3200 with (unintelligible) you can typically be looking at a 33% variation. And this is up and down so it is not necessarily 50% down, 50% up. But that is $1000 of potential variability in terms of your earnings.

So, this could be 2500 to 3500. For a small system this can be very, very important when you start to consider the fact that maintenance might be $500

on this (unintelligible) system. So, that now becomes 2000 to 3000 dollars. And that can be the difference between a 20-year payback or a 30-year payback, right. A non-incentive payback of 20 years or 30 years as well. If you have incentives and you have a 20-year payback, your real payback will be better in 20 years. But, if you really look at it, you can see that could be the whole difference between a viable project or a non-viable project, so.

You can discuss that further. And you can see that even as you go further into higher variability, it gets even more and more pronounced. And sort of (unintelligible) at the highest end. When you're looking at the highest amount of variability there, that is almost - you are almost talking about the entire amount of expected production.

So, looking at all this, we feel this makes it a pretty strong case for why wind assessment is quite important. So, with that I don't have any other information. We can take questions.

Coordinator: Thank you. To ask a question, please press star one. You may withdraw your question by pressing star two. Once again press star one to ask a question. One moment please.

And there are no questions at this time.

Karin Sinclair: So this is Karin Sinclair. I maybe have a question, I'm not sure.

Cullen Kasunic: Okay.

Karin Sinclair: So would some of the state incentive programs use this tool to help determine whether a project would be considered eligible for their incentive benefits?

Cullen Kasunic: Yes. Currently our tool is being used right now in the state of Oregon to determine the incentive benefits. And we are currently an eligible option in the state of New York. If you purchase the study from us, the state of Oregon actually has contracted and all incentives there are - at least your energy trust, are estimated through our system.

Karin Sinclair: So, the energy trust (unintelligible) not the potential customer?

Cullen Kasunic: That's right.

Karin Sinclair: Okay. And have projects been denied as a result of this?

Cullen Kasunic: What we have been doing with the energy trust so far is -- they haven't set up any criteria for denying projects. So we have seen a number of projects that the wind speeds are lower than they had hoped. And that impacted the size of the incentive. So it is an estimated production incentive. So the less wind they have, the less cash grant.

Because of that, they haven't set a threshold to say below this you don't get anything. But what we are - what they are building is a system to help kind of pre-screen locations to see whether they are worth doing this study. And it's up to them whether they would want to set a minimum threshold at any point.

Karin Sinclair: Or could another option be to be - propose the project (unintelligible) be mounted on a taller turbine if that would generate appropriate production or something.

Cullen Kasunic: Yes. In the studies we do we typically provide three tower heights. And so that's exactly right Karin. And even if the tallest tower height option weren't

there, it would incentivize then to put it on a taller tower to, you know, to get the cash grant.

Coordinator: And we have a question from the phone lines. It comes from (Nick). Your line is open.

(Nick): Hi Cullen. Am I on? Can you hear me?

Coordinator: We hear you sir.

(Nick): Okay, fine. As long as nobody is going to ask any questions except Karin, I thought I would have at it. I have several different questions. You said the relevant distances that you - this was the second or third slide. The relevant distances that you use are 500 meters and 1500 meters for obstacles and terrain.

Cullen Kasunic: That's right.

(Nick): And typically, you know, the thumbnail or the, you know, the rule of thumb that site assessors have used forever have been 500 feet of 500 foot radius (unintelligible). So you are going considerably beyond that to take a look at land cover and obstacles.

Cullen Kasunic: Hello?

(Nick): Yes. I said you are going considerably beyond that 500 feet for your relevant distances. It's just a comment. And your feeling is - one of these feelings is that is appropriate to go those distances that far.

Cullen Kasunic: Yes.

(Nick): Okay.

Cullen Kasunic: Your question is do we feel it's appropriate to go those distances? Is that correct?

(Nick): Yes. I'm just quite surprised because the rule that has been in existence for thirty something years is the 500 foot rule. I'm just surprised, that's all. It's a comment I guess.

Cullen Kasunic: I'm sorry, you are cutting out.

(Nick): Okay. We may need to reconsider the rules of thumb we use from 500 feet to something much greater.

Karin Sinclair: Right. So maybe the question is - why are you going out that far?

Cullen Kasunic: I'm still not hearing you but let me respond to this. Typically we will say 500 meters for obstructions. That's about 1500 feet. And that is an outside distance for it. When we are looking at land cover, that's another story. We have found significant variations of land cover as you go further and further out. In many cases, actually we do see some variation that's just outside of the range.

And if, for example, you're at the edge of a change in land cover type - if this location were further inland, for example, that's on the map here. And it were not being - and the fact that it was somewhat near a large water body was not being accounted for. There would be some difference there that should be captured, that should be realized. So that is something that we have seen.

That's why I mentioned that we have that kind of third level that goes out to five kilometers. It doesn't take a lot of weight into account. But it does capture the fact that changes in the lands cover and terrain, even further away can have some impact, so.

Coordinator: Once again, if you would like to ask a question press star one.

And there are no questions at this time.

Karin Sinclair: Well I guess if there are no additional questions, I would like to thank you Cullen for putting together this presentation and taking time out of your day to give it to us.

I think it was a very interesting presentation. And a tool that, you know, may be used in other places besides New York and Oregon going forward. So, I guess I will just say - thank you very much. We have another webinar scheduled for September. And also at the end of this webinar, we are going to commence a business meeting for the (unintelligible) division. So anybody who is interested in staying on for that, please do.

So I think we are wrapping up here.

Cullen Kasunic: Karin?

Karin Sinclair: Yes?

Cullen Kasunic: Oh, I wasn't sure if you had finished. I think you cut out on my end here. This is, yes, this has been a good opportunity for us. And thanks a lot for having us present here. We have been busy but it's our pleasure to share with you what we have been doing and where we are at and our results. And so, look forward

to your September webx. And hope to be able to join on that and be a participant and listener.

And thanks a lot.

Karin Sinclair: Okay. Thank you.

So please don't disconnect people if you want to stay on for the meeting. But for the operator, I think we can stop recording now.

Coordinator: Thank you.

END