WIND TURBINE/RADAR INTERACTIONS

April 20, 2011

Coordinator: Welcome and thank you for standing by. All participants will be in a listen-only mode throughout today's conference.

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 Ian Baring-Gould Technical Director of Wind Powering America. You may begin.

Ian Baring-Gould: Hello everybody and thank you again for attending this month's installment of the Wind Powering America webinar series. And in this case we are going to be focusing the Webinar on wind and radar interactions and we actually have a great panel today that is going to kind of walk us through what The Department of Energy is doing in regards to looking at the wind radar issue and then also presentations from The Department of Defense and NOA in regards to the kind of interactions that we see with wind turbines and radar issues.

So I want to get to the presentations quickly because that's what everybody is tuned into. We're going to do questions at the end of each session which is a little bit different than what we normally do. But because the presentations themselves are so different we want to allow kind of direct conversations after each presentation.

You see it on your screen there so to ask a question as always we're doing this by typing them in. So you can go up at the top of your window and under the Q&A tab just like Q&A a little window will open up and you can type your

questions in and then at the end of each session we'll take about five minutes to run through the questions. Depending on how long we go we'll try to address any questions that we might have at the end of all of the presentations so if I don't - am not able to get to your question hang on and we might be able to get to them at the end.

So without further ado I'd like to (introdo)- introduce Jose Zayas. Jose is a Senior Manager at the Sandia National Laboratories and has worked extensively in the renewable energy field. He spent ten years specifically working in wind technology areas before he was elevated to look for Sandia across the whole renewable energy platform. He's also done a lot of work in advanced water systems and is currently one of the technical leaders of DOE's activities as I said looking at wind and radar interactions.

So Jose is going to give us a presentation on what The Department of Energy is doing to address these issues. So Jose.

Jose Zayas: Well thank you Ian and good afternoon to everybody it's really a pleasure to be with all of you at least giving a quick perspective of what The Department of Energy has been working on over the last year specifically on wind radar and trying to address these challenges. And my intent is to give an overview and of course start talking about some of the technical details and some of the findings that have happened over the last year.

So of course many of you may be familiar to the evolution of wind energy but for those of you who may not it's important to recognize that as we have experienced as an industry growth throughout time these machines have grown into quite a large size where today in particular to land based technology we're looking at machines in the range of 1-1/2 to 2-1/2 in some cases 3 megawatts in size. And of course as we reflect offshore and some of

the installations that are happening in Europe we're looking at a 3 megawatts plus.

The reason why this is important is when we - you look at the schematic where the machine sizes are today the intrinsic size of the machines has really elevated some of the concerns around their impact when related to wind and radar interaction. So again that's really going to serve as the basis of the dialog today and I'm primarily going to be focusing on this particular size of machines and as I go through the presentation try to capture its impact moving forward.

So when we look at current installations just a bit of background of course we have seen a record set of years throughout the last five or six years with 2010 being somewhat of a step backwards in comparison to our - to the 2009 but today we sit at 40 gigawatts or so or 30 states with again 2010 being a little bit over 5 gigawatts and '09 being close to 10. And although this industry has shown its ability to scale up it's important to recognize that as these numbers continue to grow barriers and challenges such as the one that we're discussing today will surface up.

And when we look at that center part of the country near the bottom right of the slide right in this area right here, what you'll find is of course that that's an area that's very rich for wind resource and where a lot of projects have been proposed or have been installed. But in many ways these areas also kind of have a conflict with a lot of our activities that will be explained by the presenters to come.

When we look at the 2008 report that was issued by The Department of Energy the 20% by 2030 wind scenario this chart here just tries to illustrate the expected installation throughout that time. And again this also kind of

shows from an annual basis over the last four years how these installation trends have evolved. Again 2010 was somewhat lower than 2009 but from the DOE's perspective this trend in general of course is ahead of the projections of this scenario.

So the reason I also share this slide is to kind of reflect that as we start getting closer to these numbers again these types of challenges like the one that we're discussing today and other settings through Wind Power America you're discussing environmental issues and so forth, again it's important to reflect that these challenges will affect the deployment for this industry.

When we take all these things that I just mentioned these last three perspectives and we look at near the top of the slide we're looking at the wind resource itself when we start looking and overlaying the situation today of the different radar networks that are out there and you overlay them and then you put it into perspective from the 2030 report scenario which is in the bottom right.

What you'll notice is that as we project forward in time and this scenario tries to capture how the deployment will evolve it's easier to recognize that these - siting these projects will be more problematic if we do not continue to strive at addressing the various mitigation options needed to continue to exercise and explore higher penetrations of wind energy and at the same time being respectful to the mission of The Department of Defense and Homeland Security and others in terms of military activities and of course the jurisdiction for FAA and NOA.

So again balancing these elements and having an interagency perspective and coordination is key and what will really be the theme of the slides to come for the rest of the afternoon.

When we look at wind radar and the issues again some of you may be more familiar to this than others, what you'll recognize is that wind turbines are large electro magnetic reflectors and will have an obstruction to the radar independent of that mission because our radar network is both quite complex and the mission is complex as well. Radars today is - have a challenge in discriminating between the turbine is either moving or static which is often referred to as either clutter or Doppler.

Wind turbines can pose an obstruction to aviation safety and federal agencies all of which if not sited property these are very true statements and can create - make second barriers in siting and permitting. And again it's important to reflect that when we look at the entire elements of how do you site a wind project there is not a single entity responsible for the entire approval process. So again coordination between these elements is key to the success moving forward.

When you look at a 2010 numbers in terms of projects that we're trying to go through the permitting process and so forth what you'll see is that almost a doubling of the amount of installations were either delayed, deferred or abandoned due to some sort of impact related to radar. And again those can range from aviation safety from a military activity and so forth. So as we move forward this number potentially if not mitigated will trend to go upwards.

Coordination from our perspective is key although today I'm very fortunate to be representing The Department of Energy. It's important to recognize that only DOD, DHS, and FAA or Department of Transportation and Commerce experts can determine if the mitigation is acceptable. So over the last year we've been working tightly in coordination with these agencies and folks like

Dave Belote and folks from NOA and FAA to try to develop a coordinative framework of how we can pursue different potential opportunities for mitigating these things.

And these may range from impact studies optimizing the wind form maybe modifying the look angle of the radar, looking at things that can be done to the turbine in terms of making them less impactful to the radar and so forth. And again the point that even though DOE is not a signatory in the process as the lead agency committed to energy deployment in our nation their commitment is very real and their investments are significant in this area.

When you look at our work at a high level it's important to recognize that we are focused on developing technology options to reduce the reflectivity of these turbines on the system. And - but it's important to recognize that every time that we're trying to develop a mitigation for these turbines there's a lot of challenges that we face as an engineering team from economics, we don't want to make these machines too expense where their viability really gets impacted significantly.

How do we do it in such a way that we're not going to also affect the operations and maintenance of these assets in the remote site that there are and so forth? And again our focus to date has been on the rotor but it - I just encourage all of you to consider that the program is significantly more comprehensive but our historical program has been looking at the rotor because all the moving parts are there, all of the moving parts are what create a Doppler impact to the radar and so forth.

But again as we pursue these mitigation options we're also looking at how do they translate to towers and other components of that nature and of course work very closely with the DOD and the FAA and others to understand what

could be done to the radars. And all of those pieces really kind of comprise the entire strategy that I would quantify the Federal Government is pursuing in trying to address these concerns.

Our approach just in a little bit more detail is again looking at reducing the signature of that machine. We believe that if we can make the turbines look smaller to the radar by reducing its signatures its impact over all impact on the radar would be much better. And again I want to make sure that all of you understand that this is just one option of the many options that I alluded to earlier. We were looking at upgrades on the radar, we're looking at software upgrades, we're looking at what can be done to the turbine, what can be done in terms of the wind farm itself.

So some of you may be familiar to gap filler technology or infill systems and so forth. It's really the comprehensive portfolio of mitigation options that from now on are being looked at. And again this program that I have on this slide really was the target of last year's heavy involvement and will continue but it's significantly more comprehensive today.

Here are some examples of how we are looking at the problem. The very, very challenging problem for many different reasons but again from a quick perspective if you look at the right side of the screen here this is some of the analysis. And again what this circle represents is the (admuthal) angel to the radar from the wind turbine. And what you'll notice is that the Blue line depicts how is the signature to the radar today.

And of course you see these higher areas here higher impact because that's when the machine is directly pointed to the radar or directly away from the radar. And the mitigation options that we are pursuing will reduce the signature to this Red section that I have just checked here again making the

machine look significantly smaller to the radar which of course will have some intrinsic benefits to - in terms of the impact.

And this slide here and other material will be on the WPA site just to show the different elements and analysis that the rigor that has to be done to access this material it's - and all being done from the constraints that this industry poses which are economics which are operations of maintenance and everything else that I've said before.

Here's just a schematic of how a blade may look like in the future with different elements or different options again trying to address a particular impact or in a particular area and so forth.

When we - one of the things that we're pretty proud of that we did last year is that we actually decided that as we were moving forward The Department of Energy needed to get together with The Department of Defense and they sponsored this interagency workshop.

And the intent was really to try to get key stakeholders from all of the different agencies to come together and have a dialog and develop a strategy moving forward in terms of how do we address this? How do we invest in the different mitigation options? And how do we have a coordinated strategy that enables the entire Federal Government to collectively try to address the various facets of this challenge?

And a lot of things came out of this workshop the key takeaway point here is that 26 unique R&D activities the last bullet were identified. And now we are systematically going through the process of understanding who invest, who works on this and so forth. And I think it will be very beneficial for the mutual interest of the industry and the Federal Government.

So moving forward again it's important to recognize that DOD and DHS are the only ones who are going to continue to work on these different studies and DOE's commitment is very strong to addressing these challenges.

And with that I'm going to close. We believe that there is a future where wind and radar can coexist and I hope that some of you at a quick perspective got to see that there's some strides by the Federal Government to coordinate an effort to address these challenges.

Ian Baring-Gould: Great thank you Jose. Does anybody have any questions for Jose in regards to the DOE program area? And if not we'll continue to move on and then people can ask questions that we'll get to at the end of the presentation. So give people a few seconds more.

Okay so moving on the next speaker that we have is Dave Belote and Dave is a very special guest here. Here is currently the Director of the Department of Defense Energy Siting Clearinghouse which is based out of the Pentagon. Though Dave is currently giving us the Webinar from some highway interchange but somewhere North of or South of Denver as he's driving to Denver International Airport. So Dave thank you so much for taking time out of your really busy schedule to come and talk to us.

Before joining the or taking over the leadership of the Energy Siting Clearinghouse Dave also worked as a based Commander and worked with the siting of several large PV projects primarily in Arizona. So comes with a host of renewable energy experience and then currently is leading of this activity to allow renewables to play a role in meeting Department of Defense energy needs while still maintaining the national security issues that The Department of Defense is charged with.

So Dave.

Dave Belote: Thanks Ian and you see the get on the stage slide just has my name to advance to the slide titled America's Military Missions everything that Ian said is true. I got some PV experience, I got a lot of concentrating similar experience. And those of you who say, okay we understand DOD might have some mission impacts. What are they? How close to a military base or range or route can I put a wind farm? My answer is depicted on this slide is going to be it depends because the United States Military has a wide range of missions across the country and across the world.

And depending on the precise mission in a given area there are different impacts of wind turbines and other tall things with large radar signatures. Sometimes it's simply, you know, messing up the radar that a young pilot in his airplane is - or her airplane is going to have. More importantly if we get into the test world there are some places in the country where we do very sophisticated sensitive things and large spinning things can confuse the very sensitive equipment that we have to test American equipment.

We also have the North American Aerospace Defense Command and US Zoning Command doing border surveillance, coastal surveillance and internal homeland surveillance with a network of radars and in the wrong place a wind farm can kind of put the eyes over the four star generals whose job it is to take a look and guarantee that the homeland is safe.

Now if you advance to the slide titled Renewable Conundrum we never knew this was going to be a problem until just a few years ago. We didn't know that there was a big issue with interference on some of our systems nor was there any way for us to really find that out. Fifty states more than 2,000 counties, a

federal system that's decentralized across the country, seven different transmission organizations across this country.

There was nobody who thought it was their job to call DOD and say, you know, we want to build this, you know, set of very tall skinny things close to you. So the only way that we had to find out is 30 days prior to construction anything that's going to be 200 feet tall or taller the developer has to notify the FAA and request a permit for construction. Well that was a little bit too late for DOD to be able to do any of its work and because of this splintered decentralized system we found ourselves in a couple of jambs.

Now advance you'll see the first slide that about two and a half, three years ago DOD started realizing tall things close to sensitive capabilities could create a problem. Now this is actually about concentrating solar rather than wind farms but just the interference caused by a single tall tower with an IR collector on top arranged by a bunch of mirrors is illustrative of why wind farms create issues. I was the Base Commander at Nellis Air Force Base and I was responsible for the 2.9 million acres you see here that is the Nevada Test and Training Range.

I had no idea why the president of a solar corporation wanted an office call but he came one day in October of 2008, started a year and half process trying to site a solar plant with a really great technology involving molten salts and concentrating solar. And I blocked him because it was too close to the Nevada Testing Training Range. It was too close to some very sensitive capabilities that you could - I could never go out and talk about. In public I would be pushed and said, what is it the DOD can possibly have there that just, you know, creates the problem.

And I simply said, I'll never be able to tell you but in certain frequency bands that we care about that creates too much background noise and we continue to look for sites on BOM lands farther and farther away from the range borders and ultimately Senator Harry Reid got involved, wrote the Secretary of the Air Force and when your Base Commander and the Senate majority leader writes a letter that says, why is this guy blocking this cool project from my home state it gets attention.

Well it got the right kind of attention fortunately MIP's Lincoln Laboratory got involved on behalf of the Air Force Scientific Advisory Board. They checked all of our homework and we found the site 35 miles from the range border that the background noise was okay but that's not a great situation taking almost a year and a half and having to get the Senate majority leader involved before DOD could jump into the game and find a suitable solution for industry.

If you advance to the next slide Shepherd's Flat we were unprepared. Some of you may be familiar with this particular site.

About 300 turbines up on the Oregon, Washington border, Columbia Gorge Valley fantastic wind resource and after six or eight years of site study and investment 30 days prior to construction in the FAA process DOD is notified this time it's not an Air Force Colonel Based Commander who is slowing the project down it's an Air Force Four Star who was the Commander of US (unintelligible) Command and he said, look there's a radar here one of our network of Homeland surveillance radars and you essentially are going to put my eyes out it the Northwestern corner of the United States.

That as you can imagine almost made the wheels fall off because GE and (unintelligible) at this point had invested nearly $2 billion and we had some

rudimentary analysis but we really didn't have the tools in place to do nuance analysis and when industry and outsiders looked at our homework they said, look this does not stand the test the four star is out there basing these claims on, you know, rest and great science.

And at this point the Senate got involved again and MIG's Lincoln Laboratory got involved again told us that there were algorithms and processors they could design for not too much money that would mitigate the problem. And based on their analysis DOD went ahead and accepted these 300 turbines and an additional 1,100 turbines close by. We're in the process right now of trying to field test the MIC solution.

Advance to the next slide Renewable Conundrum Number Two. Congress at this point decided that this was not good enough. Air Force Colonel, Air Force Four Star, people in other services they wanted a much more rigorous process in place. They wanted teams who could do the analysis and they wanted to have us stop costing industry hundreds of thousands of dollars and maybe millions of dollars in delays so they got involved.

Next, the slide titled 2011 NDAA the National Defense Authorization Act that was passed to the last December's (unintelligible) session signed by the President on January 7 it essentially directs DOD to get its act together and says, all these things that get filed with the FAA you've got to be able to deal with much more effectively and quickly.

Next slide, the key elements of Section 358 it says, you have 180 days to clear the backlog of everything that you have ever slowed down through the FAA process. You have 270 days to create a strategy that will allow you to know where the high, medium and low military machine impact areas are in the country. And we are going to set a very high bar on you accessing these

hazards if you want to object to a project through the FAA only four people in the entire department can do it, the secretary, deputy secretary, undersecretary for acquisition technology and logistics or his principal deputy undersecretary.

Now the lowest of those guys is about the equivalent of a four star and really, you know, when you talk undersecretary or deputy secretary of defense that is a huge bar for us to be able to get over and if that weren't enough Congress said, if you have one of these guys object to the FAA you owe us a report in 30 days that outlines the unacceptable risks to national security and describes the mitigation strategies that you considered and why those mitigations won't work.

So as you can imagine that sets a very high bar for us to find some mitigations that will work the partner with industry and other government agencies so that we have a menu that we can select from and get past this problem. Now there was one sweetener that Congress gave to us it allowed the department to accept voluntary contributions from developers to mitigate for a given project which is only fair because you shouldn't pass the toss the, you know, entire base of taxpayers if someone in a given area says, we want to put a wind farm here it'll make us money, it'll be good for the country.

Well they can now come to the table with a few hundred thousand dollars whatever it may cost and say, one of these gizmos that DOD, DHS, FAA, you know, with cooperation from DOE has agreed to accept will pay for it and let's go ahead and build.

Next slide, these next couple don't matter to ya'll as much just recognize that this is designed to pull in all of the services and the significant functional areas within the office of the Secretary of Defense so that we can have a robust discussion.

Next slide, we planned to do that through a lose network based around a computerized pool that will allow us to very quickly plot locations of concentrating solar towers, met towers and wind turbines and compare them to the locations of our radars, military training routes test facilities and what not.

Next slide, we've got to do a key caveat this is not designed to plant anything that exists in law. It does not take away the FAA's authority to regulate the airspace, it does not get in the way of NCIA's authority to regulate the spectrum nor does it get in the way of the National Environmental Policy Act this is simply for DOD to say, we have accessed the mission compatibility of a given utility or commercial scale renewable energy project and here is what that impact is on DOD's ability to do its job.

Next slide, we do have one model for success it's already out there. The Sacramento Municipal Utilities District and ESCO and NextEra Energy partnered with Travis Air Force Base and with the US Transportation Command to figure out a way to help Travis which is the largest aerial port facility in the country not lose capability around its airfield as wind farms went in within 4.6 nautical miles of the tower they were able to find a way to do the gap filler and a optimization of the radar so that Travis never loses contact with non-cooperative traffic in the area.

The fact that industry came with a million dollars a piece and was able to do through a cooperative research and development agreement really creates the model for us to figure out these mitigations and move forward together.

Next slide, our goal because Congress set it for us is to be able to analyze projects within 30 to 45 days do a preliminary review and say might create an

impact on the military and then take some additional time where we identify that impact to negotiate with stakeholders and with industry to find the mitigations, to find ways of funding the mitigations and on really serious projects like those close to the Nevada Testing Training Range or places in the Mohave where we have some very sophisticated and sensitive test equipment, you know, to put a whole lot of effort on it.

And the final slide, my contact information my get off the stage slide and that is believe it or not me in the center of the slide. So I have gotten to do some cool stuff and had discussions about energy and dependents and national security with some fairly high level folks.

And with that let me turn it over to you all for questions.

Ian Baring-Gould: Great thank you so much Dave and a good final photograph.

We've got a number of questions for you here. One is comes to us and asks, whether the understanding is that new radar systems really don't have a problem with wind turbines and it's primarily only the older radar systems that have those issues is that an accurate statement?

Dave Belote: Not yet and it depends on if you're talking about airborne radar systems or ground radar systems. For the most part we know how to fix it but none of the new radar systems have been designed with fixes in it. Raytheon is exploring some changes to its ASR 11 Airport Surveillance Radar 11 that is the short range radar at most of our military air fields but they haven't been fielded, they haven't been approved. We're convinced that technology can fix this but we really have to have a concerted effort.

Now with some of the airborne radar systems in some ways when turbines create even more of a problem for things like fifth generation airborne radars because of how the computer processors take a look around and airborne radars are designed to track things that move, wind turbine tips go at about 170 knots and that is right in the range of the supped up Cessna that you might want to be able to find to make sure that it's not the jet power scenario with the Cessna loaded with bad things, you know, things like F22's you want to be able to dig those out of radar clutter.

So the radar manufacturers and the military needs to work throughout how to solve that as well and make them not confuse the processors.

Ian Baring-Gould: Great thank you. Another question is and you kind of covered this in your talk but the Energy Siting Clearinghouse works with all branches of the military and so in the case of offshore are you working also with the Navy to look at testing ranges and things of that nature? And then on a related question about how many projects or gigawatts of power is currently in the queue of the Clearinghouse?

Dave Belote: The answer to the first question about offshore is yes. My personal integration is more at the policy level the offshore policy working group Secretary Salazar Smart from the Start working group we have someone who works for one of my close colleagues in the readiness world is part of all of the BOEM state task forces and pulls in the Navy to take a close look at the lease (blobs).

Before Maryland, Delaware and New Jersey or Virginia put out any request for information they had already been through our process where I've got the, you know, the policy and the communications link and a couple of my Navy and OSE colleagues have the subject matter expertise to say, we can live with wind turbines here and not here. Virginia and North Carolina are problematic

because especially Virginia you have a phenomenal offshore resource on a very shallow area of the outer continental shelf where the world's largest naval facility trains and shoots live ammunition over all the time.

So as you can imagine we can't exactly put wind farms in places that the Navy is shooting live shells and missiles over. We're deeply engaged on that. In terms of what's in the queue I don't have the figure for you on mega wattage or giga wattage of power. I can tell you that there are 275 projects in the backlog representing somewhere on the order of 7,500 different turbines and met powers, 215 of those are logged with the FAA, 60 of them are with BOM where they involve right of way applications on federal land for met powers or wind turbines.

And we're making some headway but I am thankful that there are no criminal penalties in the law because I won't make it through all 700 or all 7,500 turbines, 275 projects in the six months that the law gives me. But I will make headway.

Ian Baring-Gould: Great a question about that timeline does that also include the FAA notices? So does it include all of the federal entities reviewing the project or only specifically the DOD aspect?

Dave Belote: No that's the DOD aspect of it. FAA has timelines that its responsible for. We have to reach out to the FAA and request extensions from time to time but the fact that we are out there and there is a big part of outreach to industry they know what's going on and they recognize the projects that are, you know, held up because of DOD concern. And I spend a lot of time in personal contact with VP's or affirmining directors for the eight or ten largest wind manufacturers.

I was on the phone yesterday with the Affirmining Director for Iberdrola talking the four specific projects, you know, one of them is in North Carolina and impacts a unique thing that we have on the Virginia, North Carolina border about 20 or 30 miles away from this particular site called a relocatable over the horizon radar.

The relocatable is kind of in name only it's stuck there and we use it to track bad guys in the Caribbean. And we really don't know we don't have the science fully developed how close a wind turbine can be to that unique over the horizon radar that's tracking traffic in the Caribbean Ocean - Caribbean Sea and, you know, we've asked for a 90 day extension from the FAA to try to do some homework. Iberdrola is aware of what's going on recognizes that this is a unique DOD capability and is willing to work with us on that.

Ian Baring-Gould: Great thank you. Let's take one last question before we move on to Ed. There's been a number of questions in relations to a specific project which I imagine you cannot comment on. But could you kind of list through a couple of the kind of the classic mitigation strategies that you're seeing deployed at a number of the sites that have demonstrated impact but you've been able to work around them?

Dave Belote: There are no mitigrate - mitigation strategies in place yet they're - we're working one in Kansas simply on changing the alignment of the turbines themselves so that rather than being put in a standard East, West grid along existing roads they're put along the radials of the radar so that the radar has a better chance of (unintelligible). We have to do some homework because that could be a lot more expensive for the developer and the law specifically tells us to consider affordable and cost effective mitigations as apposed to just pie in the sky, you know, things costs gazillions of dollars.

And adaptive clutter map is probably the cheapest type of mitigation that would simply tell the radar to ignore these given things because they know there is a turbine there that's creating clutter. The problem is that if you're in say a border surveillance situation if it blinds you over the radar nothing goes on the scope there but the radar knows to ignore it. Gap filler is one of linking together radars and kind of trying delating so that you are able to look behind wind farms. Infill is to put something inside a very high postal current frequency radar in a wind farm looking straight up.

Jose has alluded to some of the stuff that DOE is doing. We have - they have designed something called an Interagency Field Evaluation that would allow us to test a lot of these and the ultimate desire is to come up with a - an - a menu of options that we have all said will work that menu does not yet exist and we are in a case by case individual let's try to figure it out situation now. We hope within a couple of years to be out of that so that we know what'll work and we can just, you know, present a menu of options to industry and they can choose how they'd like to go.

Ian Baring-Gould: Great thank you Dave. We'll try to take a few more questions after we're done. But want to get to Ed's presentation. So certainly last but not least Ed Ciardi is currently a meteorologist working on the NEXRAD Radar System Center based out of Norman, Oklahoma. He has almost 20 years of experience primarily supporting NOA with Doppler weather radars and certainly has a host of experience. Formerly from the Air Force where he was a Weather Officer and then moved into the radar issues and he's going to be talking about primarily federal weather radars and the impacts of wind turbines.

So Ed please.

Ed Ciardi: Well thank you Ian it's a pleasure to be here and I do want to thank the DOE for setting up this Webinar and inviting NOA to the table to present some information on wind energy impact to the weather, federal weather radars. And I'm going to start with an overview of two of the - the two federal weather radars that NOA is concerned about. One is NEXRAD and most people are familiar with that.

But I also want to bring up another federal weather radar called terminal Doppler weather radar that the FAA owns and operates but the Weather Service taps into and we get a data feed off of. So that's pretty important to us too. I'll then show some examples and describe how the wind turbines actually interfere with the weather radar and then talk about some of the changes we're making to our evaluation criteria and how we're communicating those impacts to the wind energy developers.

And then some fine - I'll close out with some initiatives that we're working on to mitigate wind energy impact.

So with that let's start with the NEXRAD weather radar. The NEXRAD radar is officially called the weather surveillance radar in 1988 Doppler which is a mouthful. So most people know it by NEXRAD in the title it has the year 1988 which is unfortunate because this radar though designed in the 80's deployed in the early 90's it's been continuously upgraded through since deployment and it's pretty much still a state of the art weather radar.

There are 159 of these radars around the US the NWS owns 121 of them. The Air Force operates 26 most of the US but they have a few overseas ones in Korea and Japan and the Azores. And then the FAA operates the NEXRAD's that are (Oconess) in Hawaii, Alaska and Puerto Rico. The Doppler NEXRAD was designed to detect weather targets and because it's a Doppler it can detect

motion. And as was mentioned earlier, you know, wind turbines have fast movement to them and also a spectrum of velocities because the HUB is almost moving at zero but the tips are moving very fast.

So what the radar sees looks very much like weather return signal. This radar is a little bit different than your aviation radars. It's not a fan beam it's a very high resolution pencil beam with a one degree beam width. So a good part of that is that we can do some work around like look above the wind farms and I'll show you an example of that later on.

The NEXRAD itself is used by a lot of people I dare say everyone on this Webinar is listening has used or looked at NEXRAD data. And again the one thing I want to highlight with this is this radar has been upgraded all along and it has a modern digital signal processor. One of the questioners earlier asked if this wind turbine impacts only the older radars with an analog processors and that's just not true. It also impacts weather radar with modern signal processors.

The problem is, is there is no technique currently known to remove the weather signal or the - excuse me - the signal from the wind turbines from the signal from the weather. So that's the real issue there. And just a reminder that NEXRAD also supports the next - the national aerospace system and military operations and it's used by the public you'll see it on the Weather Channel things like that.

Now the TDWR they're only about 45 of those. They're pretty similar to the NEXRAD but with even a narrower pencil type beam and it's designed to detect like micro bursts and down strong down drafts from thunderstorms that would impact aviation or a nearby airport. Most of these are typically installed

within ten miles of a major airport and I'll show you a map here. Let's go onto it right now.

As I said earlier the TDWR data feeds go to the National Weather Service and we use these as a supplemental radar. Now everybody knows the wind resource area is mostly in here and through here and you can see that the NEXRAD is spread pretty evenly across the country but TDWR's are mostly in the Great Plains and through the Mid-West and the East Coast. And there's very few West of Denver I think three can count there. So just so you know there are a quite a few NEXRAD's and TDWR's where the major resource - wind resource is.

So what are the real issues and challenges? As already mentioned by Jose Zayas the size of these wind turbines are continuously getting bigger and we're only right now at about 10% of the build out for wind energy over the next two decades or so. And so our big concern is while the impacts may be small right now what happens 20 years from now when there's 90% more wind turbines out there, we're worried that some of our radars will be surrounded and some of our work arounds will not work anymore.

The other issues is we have no legal framework really to stop development right up to our NEXRAD and we've had a few proposals real close to our radar but to the credit of the wind industry I guess not one has yet been built within our desired no build zone and I'll show you that in a little bit.

Of course another issue is I already mentioned filtering out the wind turbine clutter is a real big technical challenge and we're working with the University of Oklahoma but so far nobody has come up with a good enough technique to remove wind turbine clutter from the weather.

And then in the other issue is we have very little funding to do this research in these studies so we're always looking for ways to help. And maybe the DOE I think is going to come up with some funding sometime. Although the budget - the way the budget looks it doesn't look like we're going to get much money any time soon.

So what's the real issue? Well I think Jose already went over this it really is the rotating blades that cause the problem when these are in the line of site. And for most wind turbines being in the line of site is being within 30 to 50 kilometers of the radar. Our clutter filter algorithm is designed to remove only non-moving clutter like buildings and trees and terrain. And so we really can't do anything until somebody comes up with a technique. It not only impacts what you see on the radar but this radar is highly automated and there are many algorithms that take the data and crunch out additional products like it.

The NEXRAD has precipitation estimation algorithms and these are impacted by the data that's got clutter in it. So that's the one thing a lot of people don't realize is that the NEXRAD is a highly automated system and people are always saying, well you know where the wind farms are what's the problem? Well the problem is the forecaster knows where the wind farm is but the radar algorithms don't and we haven't found a way to let them know about that.

So let's look at some examples here I'll tell you what I'm talking about with respect to seeing. Here's an example on the left of a image from Dyess Air Force Base NEXRAD down in near Abilene, Texas. And in the Purple box is some returns from wind farms they show up quite brightly there's the bright colors there. See if I can circle it here if you can see that quite well.

Now a few hours later the same radar on the right side of the screen rain showers have moved in and their forecaster who may be looking at this is

looking for some severe signatures and one of the things he's looking at right here is a V-notch which would indicate a very strong inflow into the thunderstorm causing it to ramp up and maybe drop a tornado at some point.

But he has to question himself now because it's right over a wind farm area and some of those bright spots that are showing up see if I can highlight them like there and there and there, you know, are those - how much of that is due to the wind farm and how much of that is real weather? The forecaster has no way to tell the difference.

So to play it safe he's probably going to put a warning out and I guess one of the things we've seen is the most likely impact is going to be an increase in the number of false weather warnings that go out if more - as more wind farms go in because those forecasters are going to be more cautious and, you know, when in doubt they're going to put a warning out. So that kind of explains the issue of okay you know where they're at what's the problem. Well once they mingle together it causes confusion to the forecaster.

Another example, here's an example from Buffalo NEXRAD but this is actually showing how we can work around a wind farm. Right here is some wind farm returns they're showing up quite nicely but the forecaster if he looks up one more angle he will note that the wind farm has disappeared. So this is one of the workarounds that forecasters can use in the field to figure out, you know, what's a wind farm and what's not.

This only works however when wind farms are at a good distance. This particular wind farm begins at about 30 kilometers out and is about 60 kilometers out at the deepest part. So once you're getting close though the - you have to look up higher and higher and at some point you can't overlook the wind farm anymore.

Here's an example of the multi-path scattering on the left. This is Dyess Air Force Base again and you will note some strong echoes over the wind farm right here and then some weaker echoes that like spokes extending out beyond the wind farm and this is what we call multi-path scattering. It happens when the radar energy is bounced around amongst the wind farm and it takes a little bit longer to get back to the radar so the radar which is based on timing as a signal received thinks it came from a further distance even though it actually was just bouncing around within the wind farm for a while.

If the forecaster looks up though he can - he'll notice that it disappears and he can eliminate that clutter issue. So now the Dyess Air Force Base wind farm is approximately 18 kilometers or 10 nautical miles from the radar. And this is when we begin to see the affects of multi-path scattering. And over the past three years we've kind of done an inventory of impacts and we've used that to try and figure out how close is too close for wind farms. This has been the biggest problem everybody wants to know well how close can I build?

And we really haven't had a good answer over the last three years and we've kind of changed our distances. At first we were concerned if you were in the line of site at all and that could be, you know, 60 to 100 kilometers away. But we were thinking, you know, the impacts are usually just confined to the first elevation angle and we have some work arounds there so maybe we shouldn't get so worked up over these wind farms that even though we can see them on the radar they're not really going to cause impacts.

And over the last few years we've kind of noticed that most of the additional impacts begin to occur within 18 kilometers or 10 nautical miles that would be in this range and as you get closer and closer the impacts kind of pile up on each other and, you know, at some point we start seeing impacts that in here

influence the entire range of the radar. And this is where you're so close that you're actually starting to block the beam and we have no way to look around it or over it and it impacts the entire range of the radar which is out to 240 - yes 240 nautical miles.

So we're kind of setting our boundaries at both 18 kilometers and 3 kilometers and I'll show you a map here on the next slide. This we have a NEXRAD tool on the FAA's OE triple A Web site under the DOD Preliminary Screening Tool it's been there for a couple of years and I'll give you the address for that Web site in a little bit. But the current maps on the left this is for Bismarck what it would look like if you were to enter a coordinate that was near the Bismarck radar.

And it shows the Yellow area and Blue and Gold is all line of site for different heights of turbines. And then we have this big Red circle which is independent terrain and to most (pe) most of wind developers they look at red as real bad and oh I probably can't build there but we weren't very good at communicating exactly what we wanted or what the impact was so we always really still got feedback like well okay well what do you want me to do? Can I build or can't I not build?

So we've trying to develop some new maps and they're not out there yet but in a few months they will be because we're working with the DOE triple A folks to modify their software on that Web site. The new Web site - the new maps - excuse me - will hopefully do a better job of communicating exactly what we want the developer to do whether it's not build at all or hopefully talk to us about mitigation or maybe just keep us informed about the project.

So we've come up with a mapping scheme which you can see on the right and let me see if I can pull up some marks here. Of course the no build zone you

can see marked in Red and then right outside it here is a - in Orange is a mitigation zone it's terrain dependent and that really is where you will start poking up into the second scanned angle of the radar. To us that's where the impact starts to increase a lot and our work around start to decrease. And we've kind of set a limit to that.

The Yellow area here is out to 36 kilometers although it could extend beyond further if the terrain forces turbines into the second scan or higher. But the maximum the Yellow area will go is out to 60 kilometers.

And then finally in this Green area that we're calling just the notification zone we just want to be notified that you're building out there so that because you're going to show up on the radar and when it does show up we want to know that - we know about the - a little bit about the wind farm. So hopefully those four areas are - better communicate what our issues are.

I want to close out with just going over some initiatives that we're working on to solve the mitigation issue. I already talked about the Web site on the OE triple A here is the URL to get there. I think if you Google OE Triple A you will find it and just look for the DOD Preliminary Screen Tool on the left.

One of the things we're also doing is for forecasters we've got an online course that forecasters in the field can use and actually I think anybody can go out there and take a look at that course. It was done by the Warning Position Training branch which is part of the Weather Service. They are down here in Norman so we've worked closely with them to put a course together for forecasters and it kind of explains the work arounds. Some of them I've talked to you about today.

We've also developed some GIS overlays some graphical overlays that show where wind turbines are located so they can overlay those on the radar imagery in the forecast offices. And that was just recently deployed to the field sites in the January timeframe I believe. And we've gotten some good feedback on that.

Some other things we're working with the University of Oklahoma on some potential signal processing solutions. Mostly what we've heard is that it's a real difficult problem to solve and that there won't probably be a solution anytime soon we're probably looking in the five year timeframe at a minimum to be able to deploy a working solution to the field if one can be found.

A couple of things we're working with wind turbine operators on. One is operational curtailment these are mitigation solutions that allow the operator to build in our mitigation zone but, you know, if they get too close and if severe weather is approaching maybe the forecaster can call up the wind farm and ask them to curtail for an hour or so while the severe weather moves through. We're only working with a couple of wind farm developers on that and this hasn't been implemented anywhere yet. But our lawyers are talking to their lawyers kind of thing that's where we're at with that.

The other thing we're talking about doing is sharing data. We would like to get some additional NC2 measurements especially maybe a rain gage on a wind farm. I mean wind farms already have met towers up there maybe if they had a rain gage they could provide us with some rain fall measurements that would compensate for the quantitative precipitation estimates that the radar makes that will be corrupted by the wind farm. We would need these in real time and they would be sent or near real time and they'd be sent to the forecast office.

And finally I think Colonel Belote already mentioned that there's an interagency taskforce actually I think it was Jose that mentioned there's an interagency taskforce that NOA is participating in along the DOD, FAA and Department of Energy.

And that I think is the conclusion of my presentation. Here are some URL's and some Web sites you can go to and you call always email us at windenergy.matters@noa and I do recommend going to our Web site there's quite a bit of information out there if I didn't cover something that you were interested in hearing about.

So Ian back to you for questions.

Ian Baring-Gould: Great thank you. There's one question specifically for you and then a couple for the panel. One you've kind of already kind of addressed but it's a question specifically relating to offshore wind. And the question is, whether you have done any studies to look at the potential impacts of misreading local weather phenomenon in the offshore wind case which clearly could impact fishermen and people like that who depend on pretty localized weather forecasting?

Ed Ciardi: Yes, yes that could be a problem. I really don't have much to say. We haven't done much with offshore wind but there's not much difference really between offshore wind problems and onshore. So I mean I recommend the person email us and we can give them a better answer.

Ian Baring-Gould: Great thank you. A question probably for you Ed or Jose. Is there any real difference between vertical access and horizontal access wind turbines in - from a radar perspective?

Ed Ciardi: Well from those perspective we really haven't seen many. I would suspect there wouldn't be much difference but it would be hard to know. I don't think there are very many of these that are deployed so we don't have any real experience with them. But anything that's moving and if it's large enough we will see it.

Jose Zayas: This is Jose and two things I would say. You know, from a clutter perspective which is from a simplistic perspective a surface area measurement, you know, I would argue that the impact will be the same and that translates to clutter. So the other thing to recognize though is that (blobs) intrinsically will be an offshore specialty at a lower elevation so that's another difference to consider.

The other thing is that it doesn't have the high acceleration tips. I think Dave captured it perfectly. If you think about it from a one blade rotating at the center kind of yo-yo affect you got a zero velocity vector and in the tip you have a 170. So from a (unintelligible) in particular we're thinking of a (darious) type design that clutter impact will definitely have a different signature and it might not get to the velocities that you see on a typical horizontal access.

Ed Ciardi: Yes...

Ian Baring-Gould: Great.

Ed Ciardi: ...that's true and let me add though that, you know, the weather radar we're looking at all non zero velocity. So even if it's slow it's still going to be picked up and we're not going to be wanting to filter it out because weather itself moves at all different speeds.

Jose Zayas: Sure from a weather perspective absolutely correct.

Ed Ciardi: More of an aviation answer that you gave.

Jose Zayas: Yes.

Ian Baring-Gould: Great an additional question that's kind of along these lines, is there kind of a size or a height level that kind of triggers things so if you're - if you're using a relatively small turbine at a relatively low height there's really no issue or is it basically anything that's out there in the individual space?

Ed Ciardi: Well I think from weather radar perspective it all matters how close you are and how big you are. So if you're smaller wind turbine you could probably site quite a bit closer than if you are a large wind turbine because you won't be poking up into our radar beam as much and we won't get as much return off of it. So yes size does matter in this case but it's, you know, it - there's still a point where if you're close enough and you're tall enough you'll be in our radar beam.

Most of our radars are at 30 meter or on top of 30 meter towers so they're at 100 feet. If your wind turbines under, you know, 100 feet tall it's, that's a pretty small turbine by today's standards and we probably would not be too concerned about those kind of small turbines the community scale. But, you know, all utility scaled turbines are - most of those are tall enough to cause us concern.

Jose Zayas: I would just add from more of the aviation side and I'm not sure if Dave's here to talk about the DOD side as well. Ian think about it and others I'm sorry think about it from a line of site perspective. So as Ed just captured as these radars are looking into the horizon the taller the object the more

problematic it is from a line of site. That means that you cannot get them as close as you probably would like to.

The second piece of course that if it's in a smaller tower again the surface is a surface measurement. So the smaller the machine is the less signature it has to the radar. So it's a combination of both.

Ian Baring-Gould: Great thank you. One last question for Ed. On the Bismarck side you gave there was a big dead spot at 120 degrees a number of people have asked about what that dead spot was?

Ed Ciardi: Okay they're talking - let me clear this here - I think they're talking about let's see this area right here.

Ian Baring-Gould: Yes.

Ed Ciardi: It's a - that's a terrain feature the terrain right here there's a pretty good hill and so behind it, it drops - the terrain drops off and the beam for 100 - this map was built for 160 meter turbine which is probably accommodates just about any turbine that's out there right now. Basically if you put a turbine in here where this X is the second X here we wouldn't see it at all because the beam is already blocked by terrain. I hope that answers the question.

Ian Baring-Gould: Yes I think it does. Great thank you we're almost 15 minutes past the hour and I don't want to keep everybody too long. So (Sue) could you pop up the last slide. Do want to say that although the presentations themselves will not be available. What we do have available is a full audio and visual recording of the PowerPoint - of the last hour. So although you can't download the specific PowerPoints you can certainly come back and listen to the talk again as well

as pause it on any slide if you want to spend a little bit more time looking at the slide.

So for all of those people who are on the Webinar. And then for all of the people who are not on the Webinar but you think a colleague or a friend might have interest in this certainly point them to the Wind Powering America Web site. It takes about a week for us to get the recordings on the Web site but at that point they'll be up there for anybody to view at any point in the future.

We have two Webinars coming up again monthly series third Wednesday at 3:00 Eastern. The next one is going to be on Transmission and Wind projects it's being posted by (Waltha). And then in June we're going to focus on Community Wind Projects.

So to let everybody head off thank you again everybody for taking part over the last hour. We had aboard of 170 people phone in which is fabulous. Again thank you to our three presenters Jose, Ed and Dave for taking the time to inform us and all of these people are readily available on the Web and so if you have specific questions that you would like to address to one of them they're pretty hard - or they're pretty easy to get a hold of. They might not get back to you quick but they're pretty easy to get a hold of.

So thank you all again for spending the last hour with us and hopefully we'll see you on the next Wind Powering America Webinar. Thanks all and have a good day.

Ed Ciardi: Thank you.

Jose Zayas: Thank you.

Coordinator: Thank you for participating in today's conference you may disconnect your line at this time.

END