UNDERSTANDING THE CURRENT SCIENCE, REGULATION, AND MITIGATION OF SHADOW FLICKER WEBINAR

February 10, 2011

Coordinator: At this time all participants are in a listen-only mode. After the presentation we will conduct a question and answer session. To ask a question, you'll be asked to press star 1 and record your name. Today's conference is being recorded. If you have any objections, you may disconnect at this time.

I'll now turn the meeting over to the Sustainable Energy Advantage Host, Mr., excuse me, Mr. Jason Gifford. You may begin.

Jason Gifford: Great. Thank you very much. Good afternoon everyone and welcome to Webinar Number 5 of the New England Wind Energy Education Project. This is Jason Gifford of Sustainable Energy Advantage. I'll be the moderator for today's call.

And since we have completed four Webinars to date in this series, I'll make the assumption that many of you have participate in those calls and will therefore provide only a brief introduction to NEWEEP and/or logistics for today's call.

NEWEEP aims to provide objective information in an effort to support informed decision-making. So our goal is to collect fact based information and resources and provide these siting decision makers to the public, the press and other interested parties.

NEWEEP is important because wind turbines siting can be complex but it doesn't need to be confusing. And NEWEEP aims to cut through the clutter of misleading information and provide all of you with an accurate understanding of the issues critical to wind energy in New England.

And NEWEEP also strives to help to address concerns in communities where wind projects are proposed and identify areas for future research. And that will be a theme on today's call as it has been in all past calls.

As I mentioned earlier, this is the fifth out of eight Webinars, the rest will be completed by the end of 2011. And the project also includes an in person full day conference which has now been scheduled for June 7. So I'd encourage all of you to be on the lookout please for registration information for that upcoming in person event. We hope that you'll all participate.

I'd like to make a note on objectivity. So our perspective is as a facilitator here in this program and as an objective analyst. We do understand however that objectivity may be in the eyes of the beholder. So to that end we'll do our best to deliver objective information. And we're going to do that by trying to step into the shoes of all of your, our participants, and try to provide the information that we believe will be the most objective and actionable for you.

I'd also like to remind everyone that all of the materials from not only today's presentations but from all past NEWEEP Webinars are posted on the New England Wind Forum Web site. And this includes the audio recordings, written transcripts, all the PowerPoints as well as a bibliography of additional resources. So these same resources will be added for this Webinar in approximately two weeks time.

Today's Webinar focuses on understanding the current science regulation and mitigation of shadow flicker. And it's my great pleasure to introduce the three speakers for today's Webinar.

Up first is Thomas Priestley, the Senior Environmental Planner at CH2MHill. And he'll provide an introduction of shadow flicker and the analysis of shadow flicker.

He'll be followed by Richard Lampeter, a Senior Scientist at Epsilon Associates, who'll provide an overview of shadow flicker regulations and some of the various guidance documents that are available on the subject.

And third will be Matthew Allen, a Principal at Saratoga Associates. Matthew will address some of the community concerns and methods for mitigating shadow flicker.

Now before I hand it over to Mr. Priestley, I'd just like to introduce or reintroduce all of you to the question and answer mechanism for today's call. To submit a question - to submit a question if you could please click the Q&A box at the time of the LiveMeeting window. That should allow you to enter you question. And please do also provide at a minimum your name and the state from which you're asking the question.

And like to remind everyone that since there are so many participants; for example we had over 400 registrants for the call, we ask that you submit only one question.

However, please do feel free to ask that question as it occurs to you. We will take and ask questions in the order in which they were received. So if you have a question on the first presentation, you can feel free to go and enter that and it will be in the queue when our Q&A session comes around. And we will bring these instructions back up to help you during the Q&A session as well.

So with that, I'd like to introduce our first speaker. Mr. Thomas Priestley is a Senior Environmental Planner with CH2MHill where he leads the firm's Visual Resource Practice Group. Tom has a Bachelor's in City Planning from the University of Illinois and both a Master's in City Planning and Landscape Architecture and PhD in Environmental Planning from the University of California Berkley.

Tom has more than 30 years of experience with much of his research and professional work related to the public perception aesthetic and property value issues associated with electric generation and transmission facilities. So Tom, thank you very much for joining us and I'd like to hand it over to you.

Thomas Priestley: Okay. Thank you Jason. What I'm going to try to do in the next 20 minutes is to provide a brief overview that addresses three questions. First, what is shadow flicker? Second, why should we be concerned about shadow flicker? And third, how do we go about analyzing shadow flicker affects?

So the place to start is to ask well, what is shadow flicker? We can start by visualizing the sun rising in the East in the morning, moving across the sky during the course of the day and setting in the West in the evening. As it does this, it causes wind turbines to cast shadows across the landscape. These shadows are longest in the early morning and later afternoon, early evening hours and shortest in the middle of the day.

At times when the blades are turning, they create areas of moving shadow that create a flickering affect and when these shadows fall on the ground, structures or other objects. You know, they're perceived as shadow flicker.

A little later in this Webinar, Matt Allen's going to be showing a very nice animation of how shadows of spinning blades move around on the ground near a turbine during the course of the day. He'll also show you a short animation of the affect of this flickering light as it passes through a window into the interior of a house.

Many of you undoubtedly have observed incidences of shadow flicker around existing wind turbine installations. If you haven't, a place where you'd get an idea of what shadow flicker looks like is YouTube. It's very simple. Go to YouTube, do a search for shadow flicker and you'll end up with links to about 500 video clips showing examples of shadow flicker.

A major caveat though is when you look at these video clips on YouTube, you will observe very quickly that most of these clips are presented with very, very specific points of view. So as you're watching these clips, you might be thinking - asking yourself well, to what extent are these clips providing a, you know, a full and unbiased understanding of shadow flicker that really helps to put the issues into perspective.

So right off the bat there's some very important things to know about shadow flicker. For those of you who might watch the clips on YouTube, you might end up with the impression that shadow flickers is, you know, constant. But this of course isn't true. You know, I'm really hoping that one of the important takeaways for all of you from my presentation is that shadow flicker is in fact limited in both time and location.

You know, quite obviously shadow flicker only occurs when the sun is shining and the blades are turning. And this photo is intended to suggest that certainly in New England there are - will be times when there is not going to be shadow flicker and that's, you know, through in just about every other region as well.

Spatially the areas within which shadow flicker occurs are very specifically defined. You know, as the shadows of the moving blades shift around a turbine during the course of the day and through the seasons, they end up creating a butterfly like footprint that you see here on this diagram.

This diagram shows the physical extent of a shadow flicker around a turbine. And this kind of shadow flicker butterfly diagram is something that you'll see a lot when you start looking at shadow flicker analyses.

In this - yes, in this diagram of course the turbine is located right here in the center. And you can see the spatial distribution around. Now what's very important is that distance plays a critical role in the extent of the shadow flicker affect.

In this case which is a typical contemporary turbine, the shadow flicker is most concentrated in the area within 400 meters of the turbine. In this case there are up to 300 hours a year of shadow flicker incidences in this area. But that is quite close to the turbine.

As you get further out, the incidents of shadow flicker reduces considerably. Out to 900 meters there's quite a bit less in the - in this case on the order of 30 to 100 hours per year. In the zone between 900 and 1400 you have a large area of 10 to 29 hours a year and then out here at the fringes even less than ten hours per year, so.

Something to keep in mind too is that in addition to determining the numbers of hours of shadow flicker that are likely to fall on a particular location, distance is very, very critical too in terms of the intensity of the shadow flicker because the areas in closest proximity to the turbine are the places where there is the greatest sun blockage created by the blades.

As you go further - as you go further and further away from the turbines, the degree of sun blockage becomes less and less. So the intensity of the perceived flickering affect reduces. And you can see in this case the shadow flicker is assumed to drop off to a point where it's not detectable at 1400 meters which in this case is the place where 20% or less than the sun is blocked by the blades.

And this is a standard that has been developed based on research that has been - taken place in Germany and actually has been incorporated into some of the German regulations related to shadow flicker. And for the moment it's a reasonable assumption that the shadow flicker affects are not going to continue into infinity, that there is a point at which they have dropped off to the extent that they are not going to be detectable and potential issue.

Another important thing to know about shadow flicker is that it is time limited. It does not occur at your typical receptor 24/7. It occurs at the times when the sun is at the right angle for it to take place. And what you're seeing in - on this page is a set of diagrams that have been established for a series of shadow receptors, in this case - in this case residences.

These show the modeling results that indicate that in this case the incidences of shadow flicker for this residence occur mid to late afternoon and occur for episodes that are on the - in the range of about half an hour and that these episodes occur only in the - only during the winter time and that's the case for this residence.

This residence down here the shadow flicker occurs in the very, very early morning during the summer months and in this case they occur late in the day during the summer months as well. And this is kind of typical. Generally shadow flicker occurs late in the day and early in the day when the shadows are the longest. And the specifics for each, you know, for each residence will just depend upon its physical relationship to the turbines in question.

So then, you know, why do we need to be concerned about shadow flicker? A lot of the projects I have worked on have been in the wide-open spaces. Places like Wyoming and Eastern Oregon where shadow flicker hasn't been too much of an issue just because turbines are located in these very open areas far from residences and other places of sensitive human activity.

But even here in the West we do have many landscapes where there are farmhouses and rural residences very close to prime turbine locations. So we're increasingly - this is increasingly an issue that we're looking - that we are looking at.

And when these issues come up, a couple things are raised very often. There are concerns about health. And there are concerns about nuisances. The health affects are probably the ones you hear about the most. And in particular there is reference to concerns that the flickering light created by turbine blades will induce epileptic seizures.

So here's something to remember. First of all, the flickering is measured in hertz. And as it turns out, epileptic seizures are precipitated by light flashes in the range from 5 to 30 hertz. For the kinds of turbines that we will be looking at, the flickering is more in the range from .6 to one hertz. So it's at much, much lower.

So as a consequence, there really isn't the potential for the flickering associated with wind turbines to induce epileptic seizures. And here's a link to the Epilepsy Foundation, you know, with documentation of this point.

In some cases as well when wind projects are being considered, concerns are expressed about the potential affect of the flickering in inducing nausea, dizziness and disorientation. However, proponents of wind power point out that in general the evidence to support these concerns is anecdotal and that there really are no empirical studies that firmly establish a link between flickering created by wind turbines and these issues.

So really what it comes down to - the primary reason why we need to be concerned about shadow flicker is really their potential nuisance affects. When it occurs, shadow flicker has the potential to be perceived as being intrusive. And particularly when it's perceived in both indoor and outdoor living areas, it may be perceived as annoying as well.

So there is a need for us to really thoroughly understand well to what extent are the proposed turbines going to be throwing a shadow flicker on residential areas and how much shadow flicker is there going to be? How long is it going to last?

And fortunately there are ways to evaluate this, to project a potential shadow flicker affect. As many of you are probably aware, there are a number of software packages out there that are used in the planning and design of wind power projects and in the evaluation of their environmental affects.

I suspect many of you who are in the business are probably using the WindPRO software, which has been developed by EMD, a Danish firm. And this includes a module for the calculation of shadow flicker. It's one that we have been using and in fact we have been very happy with its features.

So to predict shadow flicker affects using one of these models, first you need to put some data into the model. We, you know, start by defining an analysis area that extends about two kilometers out from the turbines. And this is sufficient to capture any residences or other receptors that might be subject to a shadow flicker affect.

Then we input the turbine locations using the XYZ coordinates and the turbine design parameters. You know, you need to know things like the hub high, the rotor diameter and very importantly the blade width. Because as it turns out, it is the blade width that determines the degree of sun blockage and thus the threshold at which your shadow flicker tapers off to the degree that it is no longer perceivable or, you know, an issue.

In addition, the other thing that needs to be put in is the locations of all residences in the project area. And I might say that coming up with the residential data is sometimes kind of a big job requiring analysis of air photos and quite a bit of sight work to validate as well.

So you can run the model using this data to prepare essentially a worst case assessment of the project using this basic data essential provides you figures on the maximum amount of shadow flicker that could occur without taking into account days when it is overcast and - or times when the turbines are not spinning or times when the blades are not oriented in a way that they would cast shadows on the receptors.

In some cases this first cut is sufficient because it can tell you right away, okay, just given the relationship of the receptors to the turbines, in fact shadow flicker is not going to be a big issue or an issue for this project.

However, if you are seeing, you know, high levels of potential shadow flicker exposure, then it is worthwhile to go to the next step to move towards a more real case analysis that then requires putting data into the model related to the hours of operation of the turbines, wind directions and monthly probabilities of sunshine.

And typically airport data is used for things like the sunshine probabilities. In the future I think that there could be an argument to put meters at met tower sites to collect data on sun exposure that can be useful for this kind of modeling work.

So the WindPRO works very nicely and has a number of quite nice outputs. One of them, a very basic one, is it will create maps indicating the locations of an incidence of shadow flicker. Here's an example of one of those butterfly maps similar to the one that we saw before. So for each turbine, you're seeing the numbers of hours of potential shadow flicker as it is arrayed around the turbines.

This one - let's see. On this one too you can see some little letters that indicate the locations of sensitive receptors. So you can kind of understand the relationship between the turbines the shadow flicker patterns and these sensitive receptors.

The model also can crank out reams of data on the shadow flicker affects as well. For example, residents-by-residents, you know, day-by-day, hour-by-hour it can indicate whether or not shadow flicker is being experienced. And fortunately in addition to this very, very, very detailed data, the system also prints out summary reports and that's what you're seeing here is a summary output.

And down at the bottom here you're seeing an expression of this aggregate data by receptor indicating the number - the total hours of shadow flicker experienced on an annual basis at each residence, the number of days per year during which shadow flicker is experienced and the maximum hours per day that shadow flicker is experienced.

These numbers I think will become - the significance of these numbers will become more clear to you during Richard's presentation related to standards. And in addition, the system can crank out tables like the ones that you saw before for each residence. It can indicate essentially the time periods - in a graphic way it can indicate, you know, the time periods and the seasonal periods during which shadow flicker might potentially occur.

And on this particular table you can see that it also identifies the specific turbines responsible for the shadow flicker occurring. I should have mentioned before that on these tables - on this side you see the hours. On the bottom you see the months. And these curve lines indicate the times of sunrise and sunset.

In addition, the model will crank out data highlighting or summarizing the annual hours - total annual hours of shadow flicker cast on all receptors by each individual turbine. And this is very, very useful because it can help you to very quickly identify okay, which of our turbines might be problem turbines in terms of potential - in terms of potential shadow flicker impacts.

And the data - another way that the data is sliced is displays, you know, for each turbine. You can have like individual little profile of its affects on individual residences in terms of times of day and seasons in which those residences are affected.

So the data actually produced by WindPRO is very, very rich. There's a lot there. It can be sliced in many, many different ways and it can provide very, very useful insights about the extent to which shadow flicker is taking place, when and where, so that you can evaluate which receptors might be particularly hit hard by shadow flicker and also which turbines are the potential sources of the shadow flicker.

So but clearly, you know, we don't want to just plop all of this raw data in front of either the project developers, the project decision makers or the general public. It would just be, you know, way, way too overwhelming and too difficult to make sense with.

So what we try to do is review this data, evaluate it, boil it down and then present it in, you know, a very, very clear (pojent) way that kind of tells the story, gets at the critical issues and in particular has a relationship to the kinds of standards for assessing and regulating shadow flicker that Richard is going to be talking about in the next presentation.

And we want to present it in a way that has some relevance for the kinds of things Matt's going to be talking about related to potential mitigation directions.

So in this particular - in this particular case it's - you can see it's a pretty simple presentation with an identification of first the receptor, you know, with a number that's key to the map. Here's the distance to the closest turbine that might be causing flicker affects. And this is in meters.

Days per year shadow flicker occurs, total annual hours of shadow flicker at that residence and here then is the adjusted days per year adjusted for cloud cover. Hours adjusted for cloud cover; duration of the longest daily shadow flicker event and the average daily shadow flicker event. And a little note here about the times of greatest shadow flicker exposure in terms of, you know, morning, evening, winter, summer, fall, spring and so on.

In some cases I've seen these kinds of tables as well where for each residence there might also be a column that adds information about landscape variables that may have an affect on the experience of the shadow flicker at the residence. For example, if there are intervening buildings or if there's intervening vegetation, that is sometimes - can be taken account in the summary table as well.

So I'm going to wrap up here. And in conclusion, I hope that I've given you at least a very, very rudimentary sense of well what is shadow flicker, why we're concerned about it and how it can be analyzed. And really the goal of al of us in designing and permitting projects is to very, very thoroughly understand the potential shadow flicker affects of each of the turbines so that the design of the project can be adjusted in a way that reduces the potential affects.

And then quite important, and Matt will be talking more about this later, with this knowledge, it would - it's also possible to adjust the operation of the project so that during times when shadow flicker might otherwise occur, the turbines can be shut down to avoid creating shadow flicker exposure to nearby residents.

So in the end, you know, I think the goal of all of us is just to make sure that our projects are designed and operated in a way that enables them to be good neighbors.

And with that, I'd like to close.

Jason Gifford: Tom, thank you very much for getting us off to such a great start. There are several questions that will be waiting for you during the Q&A session, which I always regard as a good sign for a good presentation. So thanks once again.

As a reminder to those that may have joined during Tom's presentation, you can submit questions on an ongoing basis by using the Q&A feature at the top of the LiveMeeting window. And when you're done entering your question, please be sure to remember to hit the send key so that it reaches us.

I'd like to introduce our second speaker now, Mr. Richard Lampeter, the Senior Scientist at Epsilon Associates in Maynard, Massachusetts. Richard has B.S. in Environmental Science from Lyndon State College in Vermont and ten years experience conducting impact assessments for various developments.

Richard has been involved in over 30 impact assessments for wind energy projects across the United States evaluating potential impacts ranging from noise to shadow flicker. Richard has conducted detailed shadow flicker modeling and recommended mitigation strategies to minimize impacts.

Richard thanks very much for joining us and I'd like to hand it over now to you.

Richard Lampeter: Thank you Jason for the opportunity to speak today. Today I'm going to be discussing the current regulatory landscape that exists with respect to shadow flicker with a focus on New England but also taking a look at what other regulations are out there throughout the rest of the United States.

Just to give a quick overview of what I'm going to be speaking about today in a little bit more detail. First topic I'm going to be touching on are shadow flicker limits. What types of limits are there and where do the limits apply?

Then I'm going to take a closer look at New England regulations first starting on a state and then local level. And then I'll expand to regulations outside New England. If regulations don't exist, you do need to compare to something. And I'm going to take a look at what guidelines are available.

Next I'll change focus a little bit and discuss modeling requirements and guidance for some of the inputs that you need to put into your model when looking at shadow flicker, specifically on what areas should be modeled, your modeling domain and then the worst case versus expected or real case scenarios for calculating shadow flicker. Then I'll move on to compliance issues. And then I hope to bring it all together with some conclusions.

So first, what types of limits are applied to shadow flicker? Shadow flicker calculations are presented in terms of time or the duration of the event and not the intensity. The limits or requirements are also in terms of term. Generally a limit will be in terms of hours per year. And you can see here this graphic off to the right shows a typical presentation of the impact or the shadow flicker calculations.

There's different isolines for hours per year. And in this case it's overlaid onto an aerial map of the site and surrounding area. And typically this will go hand in hand with modeling discrete receptor locations and those impacts and calculations will be presented to the client and then eventually the general public. Occasionally impacts will also be evaluated on a minutes or hours per day basis.

Another key component of evaluating shadow flicker impact is knowing where the limits apply. At a minimum shadow flicker is evaluated generally at residences. Sometimes the regulation is not specific as far as to look just at a residence. And you need to look at occupied buildings as well. So your receptor list expands to include commercial establishments, schools, hospitals and other occupied buildings in addition to just residences.

Limits may also apply to the property in general. And this is the property of non-participating landowners. And if the property is identified in the regulation, often there will be different limits for the residents than the property itself with the more stringent limits applying to the residents. And then finally at times shadow flicker will be evaluated and calculated on public roads.

Now let's get into some of what the shadow flicker regulations are in New England. One a statewide basis, there is a lack of shadow flicker regulations in the New England states of Massachusetts, Maine, New Hampshire, Vermont, Rhode Island and Connecticut. There is some statewide guidance though available in a few states.

We'll start off with Massachusetts, my home state. And there's a Massachusetts model zoning ordinance or bylaw. This was prepared by the Department of Energy Resources here in Massachusetts in March 2009. It covers various different topics outside of shadow flicker and different issues. But with respect to shadow flicker, it says that a wind turbine shall be sited in a manner that minimizes shadowing or flicker impacts.

It also says that the applicant has the burden of proving that this affect does not have significant adverse impacts on neighboring or adjacent uses. And there are no specific limits identified in this modeling - model bylaw. And therefore significant impact is open to interpretation. So what's the appropriate amount of shadow flicker that's reasonable or would not have a significant impact?

Moving on to Maine, there's a model wind energy facility ordinance there. It's provided by the Maine State Planning Office in August 2009. Again, it covers other issues outside of flicker. But with respect to flicker it says to avoid unreasonable adverse shadow flicker affects at any occupied building located on a non-participating landowner's property.

Although this guide does specify where flicker is to be evaluated at an occupied building, again it does not define a limit or what is unreasonable. It is my understanding though that the Maine DEP has used 30 hours per year as the dividing line between reasonable and unreasonable at an occupied building.

Finally in New Hampshire, they have a model small wind energy systems ordinance. It was developed by the New Hampshire Office of Energy and Planning in September in 2008. It says that a wind turbine shall be sited in a manner that does not result in significant shadow flicker impacts.

Here significant shadow flicker is defined as more than 30 hours per year on abutting occupied buildings. This is just for small wind turbines. Larger wind turbines would fall under local or state jurisdiction depending on the size of the project. But one would expect similar guidance to apply in those cases as well.

Now let's move down to the local level and we'll take a look at a few examples of shadow flicker regulations first in New England. Let me just preface this by saying that this is by no means a complete review of all of the local regulations or possible types of regulations. These are just examples and some regulations I've come across in my work with respect to shadow flicker.

And first we'll start off in Worchester, Massachusetts. They have a zoning ordinance and it includes a section on shadow flicker. It states that the facility owner and operator shall make reasonable efforts to minimize shadow flicker to any occupied building on a non-participating landowner's property.

In addition, a shadow flicker assessment report is required. And as part of that report, a plan showing the area of estimated wind turbine shadow flicker is required. And you saw earlier both in this presentation and Tom's typical figures for illustrating where shadow flicker is occurring. You get a nice isoline plot and you can overlay it over a USGS map or an aerial map and get a sense of where flicker has the potential to occur and for the duration.

Unfortunately this regulation does not have any limits specified. So it's up to the modeler, the developer as part of the report to sort of put the numbers in some sort of context and present the calculations and results that way. This regulation may not have any limits because the Massachusetts model wind ordinance that we just took a look at may have been used as guidance.

And that guidance document does not have any limits specified in it. So perhaps this was just - this was used - used that and that's why three are no limits specified here.

A town in New Hampshire, Goffstown, New Hampshire has a shadow flicker regulation. It's for small wind energy systems. Says that a wind turbine shall be sited in a manner that does not result in significant shadow flicker impacts. Significant shadow flicker is defined as more than 30 hours per year and on abutting occupied building.

This regulation has specific limits and the location on where they apply is identified. The wording you may notice is very similar to the statewide guidance, which was probably used as the template for forming this regulation.

Switching back to Massachusetts; Newburyport, Massachusetts also has a shadow flicker regulation. It states that a wind turbine should not result in significant shadowing or flicker impacts. As with the Worchester regulation, no specific limits are identified.

And again, an analysis is required but what you're comparing the numbers to is open for debate. You'd have to look at some type of guideline and compare the limits to that. Again, this is similar to the Massachusetts model ordinance.

Now moving out of New England, Wisconsin has the new wind siting rules. They were developed by the Public Service Commission of Wisconsin and are currently scheduled to go into effect March 1, 2011.

The Governor of Wisconsin has been pushing for more restrictive setbacks in general with respect to wind turbines and wind development. But his attempts so far have not succeeded and it appears that the rules as they're outlined will go into effect as scheduled.

The limits of these wind siting rules are applicable at non-participating residences, occupied community buildings and for buildings planned to be built. But it can't be just a plan where someone says some day I plan to develop this part of my property. There actually needs to be plans on file for a specific construction or development.

Specifically in the regulation it says that an owner shall design the proposed wind energy system to minimize shadow flicker at a residence or occupied community building to the extent reasonably practicable. The limit identified in the siting rules is 30 hours per year.

And the project owner needs to provide mitigation if impacts are above 20 hours per year. So you may meet the limit of 30 but you'll still have to do some mitigation if you're the project owner if the impacts are above 20 hours per year.

In Ohio, the Ohio Power Siting Board reviews applications for a certificate of environmental compatibility and public need. This needs to be obtained before construction can begin on any major utility facility. And a wind farm of five megawatts or more would qualify as a major utility facility in Ohio.

In part of this process the Ohio Power Siting Board requires a shadow flicker to be analyzed and evaluated. Although not specifically state under their application for certificate for electric generating wind facilities, impacts at a residence should be no more than 30 hours per year based on conditions imposed historically by the Ohio Power Siting Board.

Now switching to on a county or city basis outside New England, these are a couple examples of additional shadow flicker regulations to see some of the variety that's out there and that it's an issue that's beginning to become more and more regulated throughout the United States on different levels ranging from a state to a county to a city or a town level.

And these regulations vary depending - sometimes they're specific to large wind turbines and they may be for developments over a certain number of turbines or a certain number of megawatts or they may be specific to small wind energy wind turbines such as in New Hampshire as the model ordinance and some of the regulations that have been developed in different towns in new Hampshire.

But as time is passing and more wind energy facilities are being proposed and built, there's more and more regulations being created throughout the U.S. And you can see similarities in them. As you look at them they definitely do cross reference and look at other towns when they're developing them. So you can see common features or components in several of the regulations that are out there.

For example, here in Ottawa County, Michigan they have a shadow flicker regulation and an analysis is required as part of the items listed under the regulation. And the limits for shadow flicker are 30 hours per year at a building. And this would be a building on a non-participating property.

In the city of Hutchinson, Minnesota they also have a shadow flicker regulation. For this regulation they require an analysis. And the regulation says that there should be no shadow flicker at an existing residential structure. This is on the more restrictive side as far as regulations go.

And there's also different limits for locations away from the home. There can be up to 30 hours per year of shadow flicker on a roadway or a residentially zoned property.

And you can see as I've been going through some of these regulations that the number 30 comes up very often. And it's not a coincidence that 30 is often used. You do see a range. Generally 30 is on the upper end and that's the one used probably most often. But there are limits below that and sometimes as in

- here in Minnesota - in Hutchinson, Minnesota the limit is zero at a non-participating resident.

So next question is where does this 30 come from? And there's some guidelines out there specifically from Germany. And a lot of times when one's looking at shadow flicker for a particular project in a particular location, there are no regulations either on a state or local level.

And even if there are regulations as in - for example in Worchester there's no specific limits in that regulation saying what's acceptable or what's - how much shadow flicker can you create or result in a particular location.

So you fall back on these guidelines. And there's a German guideline on shadow flicker. The document itself is in German, which you can translate. But there's some key points that can be found in other sources, one being the WindPRO manual software package WindPRO used by many consultants and developers for looking at shadow flicker and other things as well.

And the guideline limit there is a maximum of 30 hours per year and a maximum of 30 minutes per day and this is for worst-case calculations. Also in Germany there was a court case where the court ruled that 30 hours per year was acceptable. And this is often applied as a guideline when evaluating expected shadow flicker and is typically referenced in shadow flicker analyses.

And in the absence of any regulations or when the regulation does not include that specific limit, impacts to the residents are generally compared to a guideline value here 30 hours per year. And often this German court case is what is cited as a reference.

And as the wind industry has grown and more and more shadow flicker analyses are being done, this 30 hours per year began to - I believe began to spread and that - generally in the absence of other regulations and rulings in the U.S. this 30 hours per year has been essentially adopted as a guideline and then added to different local regulations as well giving it even more and more credit as time passes.

The next portion of my talk here is going to deal with modeling guidance. At times specific modeling inputs can be requirements but more often than not, the consultant or the developer needs to depend on general modeling guidance and professional judgment.

The first critical choice in setting up the model is to decide what is the appropriate area to model or the modeling domain. And there are various ways to limit the size of this modeling domain. You could choose to look at ten times the rotor diameter. Typically this will fall into the region of a 900-meter distance.

Another method is the extent that shadow flicker can be determined by calculating when at least 20% of the sun is covered by the blade. Again, this ties back to the German guideline I just mentioned and it incorporates blade width as Tom mentioned in his presentation.

One of the more conservative approaches is to use 2000 meters, which is the WindPRO default distance when you don't - when blade width information for example is not available. And with the WindPRO software you have the ability to choose whichever one of these options you want and have data for.

I've mentioned briefly worst case and expected and Tom mentioned it as well so I'm not going to dwell on this too much. But at times with respect to limits you may be required to answer the question of when can it happen or what is the worst-case number. Sometimes the regulation may be specific in that sense or you may be specific. It says you can calculate what the expected or real case shadow flicker impacts are.

So just briefly on what a worst-case scenario is, the sun is always shining during the day, wind is always blowing so the blades are spinning and creating that moving shadow. And the wind direction is always favorable for generating shadow flicker to receiver. And you can see that this is a very conservative approach but approach that may be required for the modeler to take in certain instances if the requirements dictate that.

But as we know, the sun is not always going to be shining as we've seen here in New England in the past several weeks with all the snow we've gotten. It's not always going to be windy and the wind direction will vary. So there needs to be a way to account for this. And, as you know, there is.

To make a more realistic estimate of the shadow flicker additional inputs are needed to be added to the model. The choice on whether to be able to use these additional inputs is sometimes specified in the regulation.

But if the model does have this option, he or she needs to be - generally needs to use professional judgment in choosing and properly incorporating the data into the model. It's rarely ever specified exactly what you need to put into the model as far as specific numbers or sources of the numbers.

There may be questions and sort of a back and forth with the different regulatory authorities that are, you know, involved in a particular project and they need to be explained and you need to demonstrate that this is a valid method and you're using true and accurate and well documented data.

But the methodology and the choice is up to the - up to the user of the modeling software or the consultant or the developer whosever doing the modeling.

So to evaluate the expected or real shadow flicker sunshine probabilities are incorporated into model as Tom stated earlier and these are monthly values. And along with these data operational hours based on local wind speeds and wind turbine specifications, the cut in and cut outs wind speeds are input per wind direction sector. And this is the typical approach when looking at shadow flicker impacts.

So far I've been talking about pre-construction. But there's also the issue of post construction. I'm not aware of any post construction measurement programs. Typically shadow flicker is addressed through pre-construction modeling. Post construction evaluation is not a condition you see in project approvals.

Hopefully shadow flicker has been analyzed prior to approval and/or construction of the project so any potential issues can be dealt with before the wind turbines are built because it's certainly easies to deal with issues before they're constructed.

But once the wind farm is up and running, you may in some instances get complaints. And these complaints may be even if you met certain limits or regulations.

And complaints are generally handled on an individual basis. Can be composed of field verification by site personnel comparing the description of impacts to modeling results if modeling was done for that particular wind farm. And mitigation could be a possible outcome. And I'll let Matt elaborate a little bit on what's involved in mitigation.

But now to wrap things up, here are a few take home points on shadow flicker regulations. In general there's a lack of statewide regulations or specific guidance with respect to shadow flicker. The local regulations do exist but are generally rare. In most cases you won't find regulations.

And the regulations that are out there do not always include specific limits. And this could be based on the fact that some of the model ordinances or sample guidance that's out there say that shadow flicker should be evaluated and calculated but they don't assign a limit to what's acceptable.

Thirty hours per year of expected or real shadow flicker is generally the guideline applied by consultants when evaluating shadow flicker impacts in the absence of regulations. And often in a lot of - and the regulations that do exist if there is a limit, a lot of times 30 hours per year will be the limit you see.

So that I guess wraps things up on shadow flicker regulations and I'll turn it back over to Jason.

Jason Gifford: Great. Thanks very much. Much appreciated. Very helpful to have activities in multiple states aggregated in one place even if there is much work yet to be done.

I'd now like to introduce our third speaker. Matthew Allen is Principal at Saratoga Associates with more than 20 years experience in a specialized discipline of visual impact assessments.

He served as a peer reviewer in the development of the New York State Department of Environmental Conservation's program policy on visual assessment and mitigation and currently serves on the advisory panel updating this first of its kind guidance document.

Mr. Allen has provided scenic research management consulting services for over 31 energy projects and is frequently called upon to testify on the application and interpretation of visual assessment protocol.

Mr. Allen has a BLA from the State University of New York College of Environmental Plans in Forestry and an MS in Urban and Environmental studies from the Rensselaer Polytechnic Institute.

Matt, thanks very much for joining us and I'll now give you the floor.

Matthew Allen: Thank you Jason. I'm going to be talking about some of the community concerns and mitigation of shadow flicker. More succinctly, what does that mean? What does shadow flicker mean to those that experience it?

And first we've already been through this but I have a little bit of a different graphic. What is shadow flicker? And as Tom pointed out, it's simply the rotating turbine blade casting shadows on a stationary object. And with all the data that was presented, it's simply limited in time and location.

Some that are not familiar with shadow flicker often think that it occurs anytime the sun is out and that's not the case. It's when the turbine itself casts shadows on the receptor and that's what we're measuring.

And Tom also mentioned the potential health affects here. Why do we care about shadow flicker? And I call it real or rhetoric. You often hear when a project is proposed largely from the anti-wind community that shadow flicker can cause anything from headaches to seizures. And on the flip side of the coin, the pro wind community, will site research concluding that there's no basis for this concern.

I'm not going to comment on either of those cases, as Tom didn't. They're simply out there. I think the general consensus is that shadow flicker really falls into the category of a nuisance or annoyance. And that is very real and people do experience it as I'll show you.

What I'm going to do now is play a video that gives you a sense of what shadow flicker might look like to somebody inside a house trying to watch television or read. And Tom mentioned that there's many, many videotapes found on YouTube that show the same thing. I've done this as a video animation using 3D modeling software simply to portray that impact without giving any kind of commentary on whether it's good, bad or otherwise.

This may take a few seconds to load for people. It's already loaded on my screen but I'll give people a few seconds to let it load. But simply what you're looking at is the shadow being thrown by the turbine casting through the window and just creating a pulsating affect on the lighting in the room.

And I'll just give a few seconds just so everybody can queue up the video. Okay. I'm going to assume that everybody has seen it. And I will move back to my presentation.

Okay. And we've also covered what constitutes and impact and I'll rehash here because it's important when we get into the question of what does shadow impact mean to individual residents and how do we mitigate it. But we've talked about worst-case values versus real case values.

And again, worst case is that the sun is always shining, the wind is always blowing and the wind is always on the axis with the receptor. And a little graphic that I have off to the right shows the difference between the wind blowing in a direction that is aligned with the rotor plane versus one that perpendicular with the rotor plane and you can see the difference in shadow cast.

Obviously when it's aligned with the rotor plane, the flicker at that affected location will be less than at times when the wind is blowing perpendicular to the rotor plane.

Real case values are the much more valuable statistics. They're based on weather conditions such as cloudy days, calm winds and an aligned rotor plane. And those are the numbers that we typically look at in determining the level of impact. It's more valuable to show what a real case is versus the worst case that never occurs anywhere over the course of an entire year.

And we've already covered what constitutes an impact, the hours per year. Rich did a very good job of that - of highlighting the hours per year relative to regulatory requirements. And he talked about 30 hours per year as being the de facto standard. And in many cases it - in fact in almost all cases in the U.S. that is based on anecdotal evidence from a limited number of legal cases occurring elsewhere.

So that's certainly something that needs to be looked at particularly when you're trying to comply with regulations that simply say that you need to minimize shadow flicker to the maximum extent practicable or wording to that effect. You certainly need to define what is practicable.

Other considerations in determining how to mitigate shadow flicker again is to determine whether you're looking at real case values or worst-case values. And I recommend at looking at real case values. That data is readily available.

You can almost find - almost always find meteorological data from the National Weather Service for a location very close to you study site that could be plugged in for sunshine probabilities and wind directions as well as the frequency of wind exceeding the speed that it takes to turn a rotor blade.

It's also important to consider the surrounding vegetation, forest and structures and other things that may cause screening at a particular location. Obviously if a structure falls within the shadow of say and adjacent forest or if there are other buildings around, the affect of the flicker from the nearby turbine will not occur at that location. Obviously something that's already shadowed is not going to be shadowed by something further in the distance.

And the other speakers also mentioned the importance of project participants versus non-participants. A project participant is someone who is hosting the property and is gaining economic benefit from the turbine being located on that property.

That person is less likely to perceive that which he's gaining benefit from as being a nuisance quite obviously whereas his neighbor may feel entirely differently. He is getting the impact without any of the economic benefit.

And this slide is showing just the typical shadow pattern from a large number of turbines at a fairly large wind park. And you can see the overlap of shadow flicker in particular areas, the darker the red color, the greater number of hours that are being affected in any particular location.

And you can imagine being a homeowner in those locations that you're being bombarded by shadow from a number of different turbines. And I'll talk about that in a little while when we get into mitigation and what you look for in determining what receptors need to be mitigated.

Now also you can factor into your evaluation the presence of existing vegetation. And quite often in flicker evaluation you will simply overlay forest areas onto your map and cut those out. The assumption being that if you're standing in a forest, the shadowing from an adjacent turbine will not nearly be as great again because you're already standing within a shadowed area.

So you can see between the previous slide and this slide how that significantly reduces the area of shadow impact in a forested region of the country such as New England. You can see that that's much less than it would be if we were out in the plains where there's very little vegetation to screen. So this is a useful tool to begin to add a little more reality to your flicker study.

And what I want to do is kind of walk through a case study to talk about some of the data that was - that Tom presented and what that means to the specific homeowner. And I'm calling this the Receptor G example that we simply take one receptor out of our table here and in this case it's got its ID number of G. And you can see - now I'm having trouble with the mouse.

But if you look at the highlighted receptor that we're evaluating, the worst case shadow hours are 33 hours and 30 minutes per year with a total of 58 shadow days. And this translates down to a maximum of 45 minutes per affected day with an expected shadow value of 21 - or 9 minutes and 21 seconds per year.

So the difference between the worst case and the expected value drops from 33 hours down to or - yes, 33 hours down to about 9 hours and 21 minutes. So you can see there's a great difference between predicted worst case and actual value.

And again, here's a graphic showing the relative position of our study Receptor G to the turbine itself. And you can see we're located, assuming North is up, a little bit to the Northwest of the turbine falling in a zone in a real case value that is roughly in the low 30 hour range per year.

And further diagnosing this receptor, we go to some of the other data that WindPRO will provide on a particular receptor. And what this is telling us is that the - I'll go to the next slide and it'll highlight. What this chart is telling us is that the impact generally only occurs in the months of March and a portion of April and again the fall in October and November.

So we highlight those dates and make it a little clearer. And what it's - what the data will actually show us is that on March 1 - and this is just an example date within that impact period. On March 1 you get 23 minutes of shadow impact that falls between 7:05 am and 7:28 am. So those are generally early morning hours as the sun is coming up and still is relatively low on the horizon.

And again, you have a second period of shadow flicker during that same year and we use October 1 as an example. And on that day we have 45 minutes of shadow flicker ranging from 7:31 to about 8:16 and I believe that should be am, not pm.

So here is the chart looking at that particular example and you can see how that flicker falls. And Tom went through this showing the same type of chart.

But you can see that the flicker generally runs from the last week of February almost up until April 1 in the hours between 7:00 and 8:00 am or after Daylight Savings Time begins between 8:00 and 9:00 am. And again, that same pattern repeats itself in October.

So for the remainder of the year shadow flicker is really - is not an issue at all. The sun simply doesn't fall on the line necessary to cast a shadow at this particular receptor.

And what I'm going to do now is play a video that will show you exactly what we're talking about. When we go back and look at this table, I will show you a video that documents where the shadow actually falls when it hits that particular turbine and then what it looks like when it's missing that turbine to give you a good three dimensional view of what's actually happening during the time that the turbine is casting a shadow.

And I'll wait for this to load on individual machines. It's up on mine. I'm not sure if it's up on everybody else's yet. But what we're looking at is the time lapse animation that shows the shadow as it passes throughout an entire day. And it's set up to show the first of each month.

So the first sequence was January 1 where the shadow never intersected the house. The second sequence if February 1 where the shadow intersects the house and causes a flicker on that particular day in the afternoon for about 40 minutes.

And then we move on to March 1 and you can see by this time again the shadow intersects the house. By the time we get to April 1 the shadow has moved too far to the South of the house and no impact again occurs. So this gives you an idea of what's really happening in those charts when you see that the shadow is only hitting a home at a particular time of year.

And I'm going to assume that that has finished on everybody's PC and I'll go back to my presentation. If anybody is not able to see those animations and is interested, please let me know at the end of the presentation and I can make arrangements to show it to you in another medium.

And why do people care about shadow flicker? Well we talked about the notion that there would be potential health impacts and certain nuisance impacts. Beyond that, there's other reasons though and these are largely tied just toward public perception or people's feelings about their own property, their own private space that are not unlike simple visibility of the turbine itself.

And we kind of get into the issue of social acceptance of wind energy and I call it the backyard versus not in my backyard comparison. People generally often have different land ethics. People can view a landscape either as a working landscape or scenic landscape. And this is pretty common in areas where land is becoming fairly valuable.

Within driving distance of major cities you find that people in the agricultural industry have been working the land for generations and they view it as an economic part of their lives. Whereas when you're within a close proximity to a city, people take different value in the land because of its scenic character; people looking to get out of the urbanized state of the city and looking to enjoy a rural - the scenery of a rural landscape.

Those two different - those groups may have a very different feeling for what the value of the land is. Some may also see wind energy as a clean renewable energy source and a source of pride in their community for that reason. Others may view it as an industrialization of the landscape.

Residents also have an attachment to place. Rural landscapes are always considered special by someone and you have to respect that particular opinion. One of the things that I hear all the time is I support renewable energy but this is not the right place for it.

And when you - particularly in reasonably developed areas you see a lot of lawn signs either pro or con of wind energy and these are simply people expressing their opinions about wind energy for the reasons that I've just mentioned.

And I mentioned earlier that the opinion is often divided by public or by project participation and that's a notion of you get the money and I get the view. People don't want to get the view if they're - they don't have any benefit being derived from the project.

And there's also the economic status of individuals. Now family farms versus family estates, how do you view your property and what are you there to - how do you view the land that your property is on?

I'm going to get into the subject of how do you mitigate flicker. What can be done to minimize flicker impacts? And I'm showing you this table because this is a prime candidate for mitigation. This particular resident has three different turbines that are affecting the property, both morning and evening.

In the morning hours the property is actually being affected for a portion of the spring and fall months by two different turbines and in the afternoon by another turbine. So this particular receptor is impacted more than most. And some of the things that can be done to minimize impact or to at least address it are to establish project specific guidelines.

One of the first things you want to do is define what an acceptable impact is. And Richard touched on this and there's no one size fits all solution. This is really something communities need to look at for themselves or states need to address on a statewide basis.

But we need to define first of all are any thresholds that we established based on worst case or real case? Do we ant to be very conservative or really based on conditions that are likely to occur as opposed to likely to not occur such as a worst case.

We also want to differentiate between am and pm impacts. Some people would be - would feel less impact when the flicker occurs early in the morning. They may conclude that, you know, we're not up and about, our shades are closed; we're just not that bothered by it when it occurs in the morning.

Whereas those same people may be very bothered by the nuisance of shadow flicker in the evening if it occurs 5, 6 o'clock when they're sitting down and trying to read the paper after work. That may be something that is more offensive to them than morning impact. So that's something to look at when you're defining the thresholds.

And I mentioned you also have to differentiate between project participants and non-project participants. I heard Richard say that some regulations discount impacts on project participants simply because they're enjoying the economic benefit of the project whereas the regulations are meant to protect our neighbors who are not.

I also mention here setbacks. Setbacks are for safety, not shadow. You really don't need to say for shadow purposes that there should be a particular distance setback from a turbine because if you look at the butterfly pattern of turbines, you can see that that distance is different depending on where you are relative to the turbine.

To the North and to the South setback is really not that much of an issue. You can be much closer and never experience shadow whereas if you're to the East or to the West you could experience it much more greater distance. So when looking at setbacks as a mitigation measure, you really need to look at the specific circumstances of a turbine relative to the receptor.

And an important factor in mitigating flicker is to use computer modeling. We've largely been talking about the - what's become one of the industry standards software as WindPRO in identifying when flicker will occur. And Tom mentioned that you can print out reams of paper on everything you wanted to know about shadow flicker right down to the minute.

That data is easy to use to help identify which turbine causes shadow flicker on which receptor exactly when. And that allows you to take that data and micro site each turbine. You can play what if scenarios by adjusting the location to the turbine to diminish shadow to below whatever the threshold that you've established for this project might be.

And once you move the turbine, you can rerun the data very quickly and determine whether you've had a beneficial affect on improving the circumstance or not.

And there's also operational guidelines that can be put on turbines. Contemporary turbines have very good control systems. The turbine owners can from a laptop control many things about each individual turbine within their project including the ability to shut a turbine down when it - during time periods when that turbine is likely to throw a shadow on a particular location.

So you actually can program right into turbines shutdown times to minimize shadow flicker. Now of course if there's any developers on the phone, that's not something that they like to do because that's lost revenue, which is why this needs to be done hand in hand with establishing guidelines for your project.

What is it you're trying to achieve rather than just globally shutting down individual turbines when they're likely to throw a shadow? You want to make sure that that shadow actually is a nuisance before you do that.

A category that I call the good neighbor policy. Outdoor plantings, you certainly can plant trees that will get in the way of shadow and the trees will cast their own shadows on a property therefore blocking the shadows from the turbine. There's pros and cons to this.

Some of the pros are plantings can mitigate flicker but the cons are that light gets through the branching of the trees, even evergreen trees, the light will get through and continue to flicker on the house. So it may add some aesthetic appeal and minimize the flicker but it's not going to block it altogether.

And another con is someone may not want trees blocking views in that direction. In order for it to be most effective the plantings would have to be relatively close to the windows of your house, which of course would prevent you from having views out that window. So if you're enjoying views of your yard, that may not be a good option.

And a very simple one is to shade the windows with window blinds, shades or curtains. Some people might tend to be offended by the simplicity of that and being dictated to and say well, when shadow flicker occurs in your house, simply close the blinds. But I'm not going to ignore that as a very effective method to minimize shadow flicker.

And at that point I'll end my presentation. I'll give it back to Jason.

Jason Gifford: Matthew, thanks very much and thank you to all of our speakers for very information rich presentations today. I'd like to say right away that the two video clips that Mr. Allen had embedded in his presentation will be posted along with the larger presentations and the audio and transcripts on the New England Wind Forum Web site. So they will be available there to everyone.

We'd like to move now to the question and answer portion of our program. And we've got quite a number of questions to go through. So we're very appreciative to you for asking those. And as in our past Webinars, in order to encourage the dialog as much as possible but to also move through in a respectful and time sensitive manner, I will read the questions in the order they were received and ask one or more of the panelists to address them.

If you still have a question that you haven't yet asked, please use the Q&A box at the time of the LiveMeeting window and be sure to hit send when you're done entering your question.

Before we get to the participant driven portion of the Q&A session, I'd like to ask the entire panel to please respond to one question, which I'm going to ask on behalf of the New England Wind Energy Project Steering Committee. And the question is this.

With respect to the subject matter that you have presented on today, please recommend at least one area where additional research or analysis is necessary and please be as specific as possible with your recommendations.

I'd like to ask Matthew Allen to respond first followed by Richard Lampeter and then Thomas Priestley. So Matt if you'd be so kind to take that on first we'd appreciate it.

Matthew Allen: Sure. One of the things that I think is important and I think that's obvious from the lack of data that both Tom and Richard have presented. A lot of this is anecdotal and computer generated. We have a need for post construction case studies to understand the degree of nuisance that's experienced by affected receptors.

Right now it's very anecdotal. You look at videos on YouTube and read online postings of how shadow flicker affects residents of built communities. But you don't get a lot of information on what that really means. What constitutes a nuisance? What is actually acceptable in terms of being exposed to shadow flicker? And I think there's room for a lot of research that can be done there to try to quantify how much is enough.

Richard Lampeter: The area I think additional research and analysis would be needed in addition to that would be with respect to the appropriate limit for shadow flicker. Essentially the question is is 30 hours per year the right number. In essence right now everything generally ties back to that German court case I mentioned.

And I think some communities may ratchet that down a bit possibly to add some conservatism or they just see the complaints and the videos online and they say, well if we say that there's no flicker at a home then maybe we'll do that so that way there is - there are no complaints.

But I think we need some study into what - is 30 the appropriate number? Is it more? Is it less? And have some firm basis for that and maybe even tie in, you know, a max daily or a max number of days tied into that. Maybe that's a component that should be in there as well.

Thomas Priestley: Yes. This is Tom Priestley. I think that one of the areas that can use a lot more attention is to improve our understanding that the role that distance plays in the experience of shadow flicker, so. I think - and this actually ties in with the other research. Could be part of the same program.

I think what we need is systematic document and assessment of the intensity of shadow flicker experience at the different distances from the turbines. And this would be useful because it would provide a more tangible understanding of the affects of both distance and the percentage of the sun covered by the blades.

And then this - the understanding generated by this research could be used to test the assumption now made that the outer limits of the area in which shadow flicker needs to be considered is this, you know, 20% or more coverage.

And it can also be useful too because it maybe possible to define distance zones in which there is significant variance in the intensity and the perceived experience of the shadow flicker that may suggest the appropriateness of say different levels of mitigation within those zones. So again, I think that this could be folded into a program of host project evaluation of the kind that Matt is talking about.

Jason Gifford: Oh, thanks all three of you very much. I think it's equally as important to know what work we have left to do as much as it is to understand what we know on the subject today. And it seems to be one that's particularly ripe for more study as we go.

I'd like to move directly into the participant Q&A list because we've got lots of great questions and I'd like to make sure we get to as many of them as possible.

I would like to start - Thomas Priestley, this question will be for you. And before I ask it, it pertains to - I believe your very first butterfly diagram slide, which you don't necessarily need to go to but it was Slide Number 5 I think for your reference.

And the question is from (Dennis) in Massachusetts. And the question is does this diagram and the hours per year - is it estimated for 100% operation. In other words, the turbine may not be operating during these periods.

Thomas Priestley: Yes. I believe that that shadow flicker diagram, you know, it shows some pretty large numbers of shadow flicker. That's for the max case as opposed to the real case.

Jason Gifford: Thank you. Our next question is from (Chris) who is also from Massachusetts. And he asks the Massachusetts DP noise regulation allows an increase of 10 dBA above the L90 ambient noise. This is being interpreted to mean in increase in the L90 ambient sound level. Since the regulation is silent on how the 10 dBA increase is derived and one to think that it would mean instantaneous or L max level, why is the 10 dBA and L90 ambient allowed?

(Chris), I think that this is a great question and shows your level of detail and interest in the subject of sound. I have - or we, you know, I and the steering committee together haven't recruited this group as an expert panel on sound. So if you don't mind, I'd refer you to the two Webinars and the associated material that we did on sound.

However, I'd like to offer if those materials don't answer your question directly enough, please submit an email through the New England Wind Forum Web site. We'll contact speakers to those previous Webinars and get your question answered in more detail. Because every question is a good one. We appreciate your interest.

All right. The next question is from (Paul). And the question is is shadow flicker a problem for vertically oriented wind turbines rather than the more common three blades on a (monocle) configuration? And if not, why aren't the vertical windmills more widely used? Maybe Matt Allen if you could take a shot at that we'd appreciate it.

Matthew Allen: Yes. I could take a shot at it by - but all I can say is I've never evaluated a vertically oriented wind turbine for shadow flicker. I think we'd have to look at the orientation of that and see. I would think that the shadow profile would be much narrower than a more traditional three-bladed turbine that has a very extended rotor diameter. But beyond that, I'm afraid I have no experience with that type of turbine.

Richard Lampeter: This is Richard. I fall to the same group as Matt. That's not something I've had the opportunity or been asked to analyze. But it does make sense that due to the shape of it, the impacts wouldn't extend as far out as you would from sort of traditional wind turbines.

Thomas Priestley: Yes, this is Tom. My response would be the same as that as Matt and Richard on this one.

Jason Gifford: I have a question from (unintelligible) who is (being jockeyed) around. And his question is - I think it's a two-part question. One is the height of the turbine is referred to in one of the illustrations in your presentation - the height of the turbine in the illustration of shadow flicker over distance, I think it's maybe a question of how height - to what extent the height of the turbine impacts the distance of shadow flicker.

And the second part is a reference to the German study and says that reports that he had seen say that the German manufacturers recommend a minimum distance of one mile between wind turbine and dwellings and that the German government is considering legislation to limit the placement of wind turbines to at least 1.5 miles from residences. He asks is this an accurate representation of your understanding of the German position.

Thomas Priestley: Yes. This is Tom Priestley. You know, with the assistance of one of our colleagues in one of our German offices, last year we took a very close look at the German literature on shadow flicker and also at the regulations that have been put into place in the various German states.

And what we are finding - what we found anyway in that review is not entirely consistent with the information that our questioner has. The - yes.

Jason Gifford: Very good. Thank you. This next question is from (Ryan) and is - was to a large extent addressed in each of your presentations to the extent that information is available. But the question is what is considered an acceptable level of flicker and what is considered high? Clearly this will depend on the circumstances and jurisdictions. But perhaps Richard if you wouldn't mind just commenting to this question we'd appreciate it.

Richard Lampeter: Sure. The number you see generally is a 30 hours per year number. And that's on an annual basis and that's the guideline that's typically applied. Depending on who you talk to, they may have a different opinion on what they feel is acceptable. Someone at a particular home that is experiencing shadow flicker, they may not want any. And other people may say 30 hours is fine.

Other times the number whatever it is for a particular home maybe putting a little bit more context as Matt was showing that you may break it down into the time during the day or is it an evening shadow, how many days per year and what's the duration on a given day that you're getting the shadow flicker to put it into some context where you're not going to be having shadow flicker that entire day.

But the guideline or the regulation that's out there it's fairly frequently that you see as generally the most accepted value is a 30 hours per year number.

Jason Gifford: Thank you Richard. Next question is from (Thomas). And he asks what is the cost of a shadow flicker assessment? And this too may vary depending on what exactly is asked for. But maybe Matt Allen if you could give an indicative range for (unintelligible), that'd be great.

Matthew Allen: Sure because you're talking to three consultants here, I'd like to defer to my other two partners and then I'll answer last. No, I'm just kidding.

Generally it's fairly cost effective to do a shadow flicker study. The software is off the shelf easy to learn. Almost every consultant that works in the wind industry now has a copy of it. And it goes hand in hand with - that software works with many different facets of developing a wind far. So the data is already preprogrammed in.

Generally to do a shadow study depending on the number of turbines and the number of receptors that need to be done and how deep you want to drill down into the impact at a particular receptor, it can be done for a few thousand dollars at the low end. And if you're really going to get into going out and surveying the locations of affected receptors, it could get into maybe $10,000 or more. But I'll let the other consultants express their experience.

Jason Gifford: Well I think if I could just jump in that I think that's a very helpful answer to the question. And with respect to all the folks that have questions, I want to keep moving so we can address each of their good questions in turn.

That's a good segue. This next question is a question related to the software and (Glen B.) from Massachusetts asks - let's see. A question on the shadow flicker duration calculations; this his understanding is the software, for example WindPRO, does not factor in existing trees and other landscaping that would block the flicker from hitting a receptor; for example, a house or a window.

That the speakers hadn't mentioned that so far that the software calculated output in terms of hours very skewed to the worst case. In other words, exaggerated number of hours predicted. Again, this is, you know, a quote from the questioner.

Thomas Priestley: Yes. This is Tom Priestley. I think that the questioner is actually correct and we talked about this that, you know, kind of the baseline analysis that the software provides is the worst case. And there are a number of adjustments that you can make to get to the - something more like the real case, which includes putting in the meteorological data.

And, you know, as Matt pointed out, the software itself does not take into account the role of things like landscaping. It might be possible - it might be possible to do that but it would take - but to cut down on the numbers of hours of exposure but that would actually take quite a bit of - quite a bit of work to not only map the vegetation but then make assumptions about its height and its density and so on.

So I think probably most typically the vegetative affects are taken into account in a more qualitative way when looking at the numerical data that is developed based on the more measurable factors. You know, Matt may have some additional thoughts about that.

Matthew Allen: Yes I do Tom. Thanks. And I'm going to - I'm going to jump into another - kind of answer another question that I see on the list and hope that I can answer both at the same time.

I showed a graphic that indicated where we had cut out from the shadow flicker map forested areas. And that's relatively easy to do. And what I was really showing there was not just a simple cutting out of forest areas but an overlay of what's called the zone of visual influence map or a view shed map.

And that type of map identifies where a turbine can be seen in the landscape. And the logic there being if you can see the turbine, you can be affected by its shadow. If you can't see it, that means something is blocking your view such as topography or vegetation and therefore you're not going to be impacted by shadow.

So by taking the map that a software like WindPRO produces and overlaying using a GIS based system the zone of visual influence map you can remove those areas from the flicker map that you know will not have any visibility of the turbine because of intervening vegetation.

And one of the questions that I saw on the list was where do you get that vegetation data. And Tom was right. It can be very time consuming to gather that data if you're looking for very specific data. We don't often use specific data for that exact reason but we do use data from the National - the NLCD, National Land Cover Database, which is a free data source available through the USGS that will identify forested areas.

Many different land cover types that we call out forested areas and then we make an assumption of the tree height within that forested area based on observations. Typically we try to stay very conservative and estimate on the low side so that we error on the side of too much flicker or too much visibility being shown in our mapping. But that's how we do that process.

Jason Gifford: Thank you very much. Thomas Priestley, a question for you and I realize that this will also address the first part of that two part question that was asked earlier about height. Does flicker occur with all wind turbines and do they need to be a certain height, wind swept area, blade width, et cetera? Thomas.

Thomas Priestley: Well, I think one way to answer that question is certainly with all of the large scale utility, you know, utility scale wind power projects, the kinds of turbines that are being used, shadow flicker is certainly an issue that we need to be aware of and evaluate carefully.

You know, to be honest, I have never thought well is there some kind of a minimum height at which a turbine could create a shadow flicker affect. Certainly the extent of the area affected by the shadow flicker would be affected by the hub high size of the blade and particularly the width of the blades as well.

So presumably, you know, a, you know, a very, very small turbine would have like those that might be installed on someone's individual property might have a relatively small shadow flicker affect. You know, that's really the best I can do in answering that.

Jason Gifford: No, very good. And I think that answers a very similar question, which was asked at approximately the same time also about small power systems and whether setup was really possible for urban settings. And I think everything about your answer applies to that contact as well and of course, you know, the obstruction of neighboring buildings would also be a factor in that as well.

A question for Richard Lampeter. The question is has there been any tests or pertinent interpretation of the Massachusetts model zoning bylaw?

Richard Lampeter: As far as tests go if that refers to sort of a post construction evaluation or - I'd say not tests or like a - taking it as far as testing it in a jury or a lawsuit, I'm not aware of any in that sense where someone said that the regulations did not protect them or that they experienced too much flicker and took it to court in Massachusetts, I'm not aware of that.

Jason Gifford: And to the questioner if there was a more detailed or a different angle you're interested in, please go ahead and submit that question and we will have it addressed for you.

Next question. Richard also for you. You mentioned that shadow flicker on roadways may be a concern for regulators. Please explain how this would be a concern. It would seem that a car passing through shadows cast on a road from buildings, trees, poles, et cetera would be subject to much great and lasting shadow flicker than if the car momentarily passing through the shadow of a blade on a road.

Richard Lampeter: Unfortunately I haven't been involved in the sort of development process of any particular regulation so the thought process by regulators and their concerns I haven't dealt with specifically. I've only had to try to tailor an analysis to meet those needs.

But my sense is that a regulation would put in something about roadways because people - you see the image in someone's home and they say well if I was trying to watch TV or I was trying to read in my home it would be bothersome to me. So then you carry that to well what if I'm driving and that type of affect I encounter perhaps it would be distracting to a driver and the regulatory body would want to limit that type of distraction.

I mean it could be something you may not - with a telephone pole or some other stationary structure the shadow is not moving. You see it as you approach whereas flicker may be a little bit more sudden. And if you don't happen to notice the wind turbine in the distance, suddenly you see that moving shadow and perhaps it's a distraction to you.

So that's I think what the thought process is about including roadways in that group of locations you want to evaluate shadow flicker for.

Jason Gifford: Okay. Thank you. There are now several questions about what the typical flicker mitigation measures are and a couple questions about where the 30 hours per year comes from. I think that each of the panelists have hopefully thoroughly answered those.

At this time I'm going to move to the next unique question, which is from (Kevin). And the question is is it safe to presume that all the non-European regulations listed here are real case rather than worst case? This seems to be a good thing since worst case is a bit of a misnomer because the conditions to create it are essentially statistically impossible.

Richard Lampeter: On a European basis, I know that Sweden has a - I believe it's a real case shadow flicker number. But I'm not sure what other European regulations there are. It's typically something we don't throw - I don't throw a particular reference to that often.

In the U.S. it is - it's generally more of - in a lot of cases it's silence and you just have to interpret it and a lot of times the expected is - it's the more, you know, hence by the name it's the more likely scenario to occur. So that's the impact that's presented.

And the ones that do specify worst case or real case generally it's more of an expected case is the goal of the analysis is to show the shadow flicker impacts or amounts on an expected case basis.

Jason Gifford: Okay. Richard, I'm going to follow that up just to make sure we all understand your response and what was in the presentation you provided. There's another similar question, which gets to this point. The question is are the regulatory hour limited cited for actual, parenthesis weather adjusted impacts or are they theoretical worst case?

So I think what you're saying is that they are more toward expected and in this case the expected would be actual weather adjusted impacts.

Richard Lampeter: That's correct. For example, the regulations that I presented for Michigan and Minnesota, those were on an expected basis or likely. You'll see the terms expected or likely in those regulations. In other cases, in Wisconsin you don't see that terminology. But in general if the terminology isn't there, you would usually interpret it an model with expected as the approach.

Jason Gifford: Great. Thank you. Richard, this may be also best for you given your geographic location. The question is do you have any idea how many hours per year the wind installation at the Holy Name School in Worchester is experiencing?

Richard Lampeter: What was the - what was the location for the flicker? Did the...

Jason Gifford: Oh it's - yes, the Holy Name High School in Worchester, Mass.

Richard Lampeter: Yes. I'm not sure exactly the - I didn't work on that project in particular. And I'm not sure exactly on the orientation of the turbine to the school which would as you can see from those butterfly images that Matt and Tom had that it really depends on the direction and the orientation of the turbine to the particular location can have a big influence. So I'm not sure is the quick answer.

But if it's close and, you know, if it's on that property and the orientation is such where it's located to the North and maybe the West or East that there could be a significant amount of shadow flicker. But I just don't know.

Jason Gifford: The next question is from (Peter S.). And the question is where there are overlapping shadow flicker patterns, is it possible for the combined affect in the shadow rate to exceed threshold in hertz for epilepsy?

Thomas Priestley: This is Tom Priestley. You know, I've done a review of the literature on shadow flicker affects of various kinds. And in looking at the literature about relationship between shadow flicker affects and epilepsy, I haven't come across any studies that would suggest that this is a - that this is a phenomenon. So I don't know whether any of the other members of the panel have come cross analysis or studies to suggest that this might be the case.

Matthew Allen: Well this is Matt. From the evaluation of what the epilepsy foundation provided in Tom's slide, it appeared that the flicker rate in hertz for wind turbines was many times below the minimum rate that was quoted as potentially being a trigger for a seizure.

So imagine that if you have two or more turbines casting a shadow at one particular moment at one particular location, it could double - two turbines might double the flicker rate or the hertz rate.

But it would take more turbines than you could put in a particular location casting a shadow at any particular time to reach the rate that was published as potentially causing flicker. That's kind of a mathematical answer. I don't have a health impact answer to know for certainty. But that would be my first blush on that.

Jason Gifford: Okay. Thank you very much. And thanks to all the speakers for your generosity with your time as we address these questions beyond the original timeframe of the Webinar. I think we'd like to conclude with just a couple of more and then if there are any remaining questions after that, we will - if they're unique, we'll do our best to have them answered and have those answers posted on the New England Wind Forum Web site.

The next question is are you aware of any cases where a condition of an approved project was to curtail operations to minimize shadow flicker or to monitor actual shadow flicker impacts during operation? Matt, maybe you could start with that one.

Matthew Allen: I'm not aware of any conditions of operation that would monitor flicker, no.

Thomas Priestley: And this is Tom Priestley. I'm not aware of any cases where curtailment of - either curtailment of operations or monitoring has been required.

Richard Lampeter: This is Richard. I haven't seen a requirement that would - for a particular project that said that they would be required to curtail the operation and - or any type of monitoring program to sort of trigger that.

Jason Gifford: Matt Allen. We have a question about what the program was used for the time lapse shadow animation in your presentation.

Matthew Allen: That was 3D Studio MAX.

Jason Gifford: Thank you. When the wind is at right angle to the direction of the sun, flicker affects are minimal, how is the wind direction factor accounted for on flicker maps and tables? Sounds like maybe we will...

Matthew Allen: This is Matt. I can answer that if you like. It's not - well it's not directly calculated in on any of the maps. It's one of the variables that's input into the software and the software will then statistically determine the relative angle of the turbine to the receptor based on those statistics. The same as the probabilities of the amount of time the sun shines and the amount of - the probability that the wind will actually blow and turn the blade.

So it's just one of the variables that's plugged into the software to reach the number of real hours that the computer calculates. And then when you publish the maps, you're publishing either the cumulative real hours in a year or the worst-case hours in a year. But the angle of the sun is just one of those variables that's mapped.

Jason Gifford: Thank you. And actually our very last question here is are there sensors for collecting shadow flicker data that can be linked to wind turbine generator operators?

Thomas Priestley: Yes. This is Tom Priestley. I am not aware of necessarily of sensors that can identify shadow flicker. But however, another way to go about this in terms of, you know, if you - if one were to want to set up a very carefully calibrated system to turn turbines off and on at times when shadow flicker might exist, the thing to do would be to install a sensor that would indicate whether the sun was shining or not.

Jason Gifford: Tom, thank you very much. I would like to thank all three of our speakers for not only your presentations but your willingness to give all of us on the call so much time in answering these questions. We very much appreciate it. But thanks equally to all the participants who asked such great questions and stayed so engaged. We appreciate that very much.

As mentioned earlier, all the materials from this presentation will be posted in approximately two weeks time on the New England Wind Forum Web site. So please check for that. We will be sending a follow up survey immediately after the Webinar and would really value everyone's feedback on that.

And then finally please be on the lookout for upcoming events. Webinar Number 6, the impact on wildlife, birds, and bats and of course our day long in person conference, which will be on June 7. So please we hope you all will participate.

Thank you very much once again to our speakers and our participants. And we will look forward to everyone joining us again for our next event. Thank you very much. Bye bye.

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