17-2295-EL-BGN

FILE

3218

My name is Brenda Grieve
1380 W. Seneca Ave, Tiffin.
I co-own the Rohrbacher Farm
LLC, 1850 E CR 38, Republic,
with my siblings: Calvin
Rohrbacher, who lives there;
Kathy Kesler, who lives on the
Tiffin corner of CR 38 and SR 101;
and Mark Rohrbacher,
SR 18, Republic. We all
signed with Apex believing
it was a good thing. Calvin
may be the only one living in
the actual footprint, but it
is all four of us in agreement
for the Republic Wind Project.

Brenda J. Grieve

This is to certify that the images appearing are an accurate and complete reproduction of a case file document delivered in the regular course of business.
Technician [signature] Date Processed 4/16/18

FILE

17-2295-EL-BGN

Public Hearing Testimony for the Republic Wind Project, Seneca County Ohio, 17-2295-EL-BGN

Jim Hoffert
7240 S. County Rd 43
Bloomville OH
Seneca County

I am opposed to the construction of the Republic Wind project as designed and located ~~in~~ Seneca County.

Over the past 2 years I have attended countless County Commissioner meetings and watched Apex representatives interact with Seneca County officials. While not immediately apparent it became obvious that over the long run Apex was on a mission of deceit in presenting its projects to the County and asking for their support.

School funding is a complicated subject and Apex consistently maintained that a Payment in Lieu of Taxes program would bring in the most money for county schools. After local residents consulted with County and State auditors and tax attorneys the facts came out that Apex was misleading to the tune of $15-$20 million dollars per project.

On several occasions Apex representatives made the case that a new law they were pushing in Columbus to change wind turbine setbacks would provide BETTER protection for adjacent property owners. Not until the Vice President of Engineering from a local global scale manufacturing firm presented the Commissioners with accurate and precise drawings did Apex back off their case. It became obvious to everyone that Apex would say anything to promote their agenda, including outright lying.

Further evidence of misrepresentation came to light during discussion of the Road Use Maintenance Agreement. Even though an Alternative Energy Zone resolution was in place granting Republic Wind a PILOT when they applied for tax exempt status, Apex insisted on making the point that without the PILOT they would not be required to sign a RUMA, and eluded to the point that they would not have to fix the roads it they did not sign one. During this discussion Apex representative Dalton Carr made it perfectly clear that he was highly trained in deception tactics. Unfortunately for him some local residents called him out and he was forced to recant his misleading statements. This man's name appears on many of Republic Wind's submissions to the OPSB. After observing his interactions with local officials for two years I can assure you that he has no credibility whatsoever.

It was the combination of cumulative affects of Apex's deceptive business practices (and lease language) that ultimately led to Seneca County officials completely reversing their position on wind projects. In the beginning the Commissioners were so supportive that they hired a pro-wind attorney to support the projects during the intervention process. Now that attorney has been released and the County Prosecutor will be fighting AGAINST any wind projects in Seneca County "to the fullest extent allowed by law" as stated in a resolution passed by the Commissioners.

It is obvious to everyone in Seneca County (and by now it should be obvious to the Ohio Power Siting Board) that Apex has thoroughly mishandled things here. By applying for three wind projects and selling leases for at least two more, all adjacent to each other, they have made clear their plans to completely transform our area into a heavy industrial zone. And they have also made clear that they will do and say anything in attempting to accomplish their goals.

Much of the approval process that the OPSB uses relies on the "honor system" of the developer submitting studies and research proving that their project will be beneficial and cause no adverse harm to the local area. You are now fully aware that Apex cannot be trusted in any way to be truthful in these submissions. We already have proof that their sound studies are bogus. The massive amount of Karst formations in this area causes problems for even small scale construction here but the issue is glossed over in the OPSB staff report which leaves it to Apex to do the right thing in building its massive structures.

Do not be be fooled into cooperating with this company to enable their agenda of industrializing our area without honestly addressing the concerns of so many local residents and their representative governments. The projects are unsafe with the setback distances used in their design. The power output from the projects is not needed on the PJM grid as more than sufficient capacity already exists. The output from the turbines will be as unreliable as the wind which the wind industry admits will provide power on average only 1/3 of the time as the best case. It is not the duty of the OPSB to assist such outside corporations in going after the lucrative federal tax benefits that these projects receive. Apex, the developer of this project, has a long history of deceptive and manipulative tactics across the US and is undeserving of support from Ohio.

The process of siting wind projects in Ohio has disintegrated from its original intent. The approval or disapproval of a PILOT was suppose to give local control but Apex has proven with an adjacent project that it will proceed regardless. With this being the case, no certificates should be granted to wind projects in Ohio until some form of local control is re-established. An opportunity for a local referendum on wind projects is currently being forged in the State Legislature and will reinstate such local control. It is imperative that the people of Ohio be given back their voice in the future of their own community. The OPSB cannot be allowed to override local concerns with energy projects which transform such large areas (250 square miles in the Seneca County area alone) without local input having the final say in the decision.

Jim Hoffart

17-2295-EL-BGN

Shelley Smith <cnc.ssmith@yahoo.com>
Mon 9/9/2019 12:29 PM

If you want to use my concerns in any way please feel free.
Two children and two grand babies. I live in Reed Township. My greatest concern is infrasound and frequency. I myself as while as one of my children has autonomic dysautomia which has to do with the parasympathetic and sympathetic not reacting correctly. Many outside influences can negatively impact people who suffer from this.
The following are some of the symptoms that can be experienced.

•an inability to stay upright
•dizziness, vertigo, and fainting
•fast, slow, or irregular heartbeat
•chest pain
•low blood pressure
•problems with the gastrointestinal system
•nausea
•disturbances in the visual field
•weakness
•breathing difficulties
•mood swings
•anxiety
fatigue and intolerance to exercise
migraines
tremors
•disrupted sleep pattern
•frequent urination
•Temperature Regulation Problems
•concentration and memory problems
•poor appetite
•overactive senses, especially when exposed to noise and light

I also have a family member with sensory issues. The sound frequency, blade flicker and possible failures that cause other noises could cause many problems.
One other very interesting thing is to google search low frequency as torture.. .this all just breaks my heart.
Along with our monsanto, government and big pharma- one battle at a time!
If you choose to use any of this and need to talk to me my personal cell is 419-618-1507.
Thanks so much Mr. Jones!!

Shelley Smith CNC
Young Integrated Wellness Center
Bio-energetic Testing and Nutritional Counseling
P. O. Box 325, 201 S. Kibler Street
New Washington, Oh 44854
419-492-2129
I Corinthians 15:1-4 Ephesians 2:8-9 KJV

17-2295-EL-BGN

Mary Chappell <mechappell99@gmail.com>
Sun 9/8/2019 8:39 PM

Mr. Jones,
See the below letter I composed. Feel free to use any of it.

Sent from my iPad
Subject: My statement

I have lived in Republic all of my life. I attended Seneca East and now my children go there. I love this area and all that it has to offer. This will all change when we become an industrial wind turbine park.

I love where I live. I love being outdoors in my area. I love to take my dog on long walks and listen to the birds singing, the crickets chirping and the farm animals as they go about their day. I am amazed by my surroundings every day. The deer grazing in the fields, the eagles soaring overhead, the bluebirds flying around looking for food. The open fields broken up by the woods, I love to watch as the seasons change, all of the splendor around me.

My husband and I have worked tirelessly to create a backyard oasis for our family. We love that it is Where we can go to unwind, find peace and quiet when we need it, or family fun if we want to be loud. We have invested our hearts, hard work and our hard earned money into creating the perfect home for us.

All of this will change, if and when the industrial wind turbines come. My quiet will be constantly interrupted now by the noise of the turbines. The views I love will be destroyed by the 650 foot industrial monoliths that will be erected. The wildlife I enjoy will be driven away or even worse, murdered by the spinning blades and electromagnetic frequencies coming from the engines and spinning blades.
My health will suffer as I will be reminded every day when I look out, that I failed at preventing big wind from invading my community and home. Hopefully, neither my neighbors, my family, nor I, suffer any of the ill effects caused by these things. Studies have not been done to see what the long term effects of these monsters are on people living in close proximity to them. Republic wind will be the experiment.
All of our lives, possibly affected negatively, no one really knows. I challenge the OPSB to keep this in mind as they make their decision. Republic Wind is highly populated, with hundreds of people who will be impacted by these turbines.
Don't be swayed by big money and the environmentalists that this is best. You are appointed to these positions of power. I implore that you remember all of the lives that will be impacted if our area becomes an industrial wind park.

Thank you for listening,
Mary and Rob Chappell
Republic, Ohio 44867

17-2295-EL-BGN

Mandy Kelley <mkelleyrn4@gmail.com>
Mon 9/9/2019 6:56 PM
Doug and Mandy Kelley
Attica, OH

To whom it may concern:

I am writing to address my serious concerns with the potential for massive industrial wind farms in Seneca County and the surrounding area. I am currently raising my young family here, and I also practice full time as a registered nurse.

Much of my nursing experience comes from the emergency department setting. I spent much time working feverishly to help my patients who were critically ill, or had experienced trauma. I know what it is to monitor, work, and pray over patients while waiting for transport from medical helicopters to move these people quickly to tertiary care centers where they would receive specialty treatment. Many critical care treatments are not available in our immediate area, and often there isn't time to spend an hour or more on the highway to get help. I have heard countless radio calls from first responders calling for medical helicopters to arrive at the scene of an accident, where patients don't have hours, they have minutes. The erection of massive wind turbines would limit the ability for these type of aircraft to land in area fields. Access to this type of emergency assistance is absolutely essential to the health and well being of our residents. And our residents are far more important than any amount of money the wind industry could make in our area.

My youngest child has worked most of his life to overcome sensory processing disorder. He suffers from sensitivities to sound, touch (vibration), and light. He has spent many hours in the outpatient therapy setting, eventually thriving in our world. His home is safe and comfortable. The presence of an industrial wind turbine near our home, especially with the current setback laws in Ohio, would change this for him and for us. Our safe, comfortable home would no longer be as such. Unfortunately there are children in the area who would suffer greater setbacks than he.

For this reason we are raising our voices in strong opposition to these monstrous industrial wind turbines. We protest to protect our homes and our families. We fight for the ability to provide aid to our friends and neighbors during what may be the worst moments of their lives. We ask you to assist us in this by denying approval for the industrial wind farms in our area.

Very truly yours,

Mandy Kelley, RN

17-2295-EL-BGN

Sept. 6, 2019
Republic, Ohio

Dear Sir or Madam:
My name is Haley Nagel Carrick. My husband Colton Carrick and I have two children –Cooper who is five years old and Raelyn who will turn two on September 27th.
Colton works for Church and Dwight in Old Fort, and I work for the Buckeye Central Schools as an Assistant Treasurer. We live in Republic, Ohio, at 1145 South Township Road 81. We bought an old farm house soon after Cooper was born in November 2014. Our oldest will was five years old August. I Colton worked construction after high school, busting his butt working long days and nights, working lots of weekends, to save up and allow us to purchase a piece of land we could raise a family and call home. We have completely remodeled the house and farm and have hopes to do even more as we raise our children but the thought of turbines going in and taking away from our peaceful piece of "paradise" is scary.
I worked my way through college and my husband worked many long hours to secure what we thought was a future in Republic, Ohio. We truly hope that our future remains here in Seneca County.

But we are scared what the turbines will do for our children and our grandchildren's future also.. Colton worked in the concrete industry for years and understands the amount of concrete that will be brought in and incorporated into our land (backyard) .. What happens when they are done using the turbines or the turbines don't generate enough power to make their operation profitable? The concrete just sits then ruining the land. Please consider our concerns and thoughts as you hold the future of my family in your hands.

Haley Nagel

Haley and Colton Carrick
1145 S. Township Road 81
Republic, Ohio 44867

17-2295-EL-BGN

My wife and I are opposed to industrial turbines in our area for a couple of reasons. The biggest concern is water. What if our well becomes contaminated or even worse water disappears because of the unusal underground area. What do we do then? We have no river or lake in our back yard to fall back on. You could drill a new well but can you guarantee a good well? Sulpher is a real concern and the deeper you go the better chance of sulpher.

We also feel it would effect our property values. Who wants to live next to a 600ft turbine that could throw a bird or ice or whatever through my window or even on me. This area is too heavily populated. for turbines

Field drainage will also be spoiled + fixing it would be difficult maybe imposible to fix.

Shirley Wagner
Dale Wagner

17-2295-EL-BGN

September 12, 2019

To Ohio Power Siting Board:

I am writing to you today not only as residents and landowners of Sandusky County but more importantly as concerned parents of two young daughters. As I am sure you are well aware, there is currently a divide amongst the residents of both Sandusky and Seneca counties – a divide that is very disheartening. We frequently drive through both counties and the number of yellow and black "no wind turbine" signs that we encounter is completely overwhelming; there are so many families (not just ours) that are opposed to these giant monstrosities. If you ever have the opportunity to make the drive, we highly suggest you do so because not only will you see the most beautiful countryside, but you too will see the amount of opposition from the voters in these wonderful counties.

We bought our small farm to build a home on, to start a family, to watch our children grow and to one day retire with the hopes that our children will take over the family farm one day. However, the research that we have done regarding the health hazards of these large wind turbines has us fearful for our children as well as other children in the counties that will live SO close to these noisy giants. Following are just a few sources that we have found that will allow you to see for yourself the health hazards, also called "Wind Turbine Syndrome", that have been researched and have occurred in people living so close to the turbines:

Wind Turbine Syndrome:

1. https://abcnews.go.com/Health/wind-turbine-syndrome-blamed-mysterious-symptoms-cape-cod/story?id=20591168

2. https://kselected.com/2017/05/09/wind-turbine-syndrome/ (As stated by Nina Pierpont, MD, PhD, "Sometimes it's advantageous being a country doctor. Six years ago I began hearing health complaints from people living in the shadow of these gigantic turbines. At first it was merely local and regional, then global. Tellingly, virtually everyone described the same constellation of symptoms. Symptoms that were being triggered, I began to suspect, by vestibular dysregulation.

(1) Sleep disturbance. Not simply awakened, but awakening in a panic ("flight or fight" response).
(2) Headache
(3) Tinnitus
(4) Ear pressure
(5) Dizziness
(6) Vertigo
(7) Nausea
(8) Visual blurring
(9) Tachycardia
(10) Irritability
(11) Problems with concentration and memory
(12) Panic episodes associated with sensations of internal pulsation or quivering, which arise while awake or asleep. (This latter involving other, non-vestibular organs of balance, motion, and position sense.)

None of these people had experienced these symptoms to any appreciable degree before the turbines became operational. All said their symptoms disappeared rapidly whenever they spent several days away from home. All said the symptoms reappeared when they returned home."

3. https://www.theaustralian.com.au/news/inquirer/wind-turbine-syndrome-infrasound-and-fury/news-story/e37355190a3c4c262f78ec166582cf02

The following article also discusses firsthand experience from people directly affected by wind turbines. I can also provide more articles just like these upon request.

1. http://www.windaction.org/posts/19796-wind-turbines-help-create-energy-but-also-disturb-peoples-homes#.Wy_p_adKjcc

"For those of you that are fighting for proper setbacks from your home, do not give up because the results are 20 times worse than even I thought. My wife has not slept in a long time."

The symptoms these people are experiencing are not only from the loud noise of the turbines but also from the shadow flicker that is encountered. Imagine if you will, you are sitting in your living room and your 5 year old daughter is flipping the light switch on and off, on and off, constantly. What would you do? Unfortunately, the shadow flicker that is experienced by these wind turbines can't just be "shut off". If you google "shadow flicker" on You Tube you will see our concerns for the noise and shadow flicker associated with the large wind turbines that many are experiencing – wind turbines just like those that will be a part of the Republic Wind Farm Project.

The height alone is intimidating enough. These wind turbines that will be erected in the Republic Wind Farm Project will be almost 600 feet tall! Would you feel safe with one of these in your backyard??

Our children love to ride in the tractor, "farm with daddy" and walk the fields with their daddy but as this wind project stands, we will have three of these turbines way too close for comfort. As parents, we am fearful for the safety of our girls and therefore, they will not get to experience farming with their father if these turbines are erected. Would you allow your children or grandchildren to play near these things? We just can't get over the "what-if's". What if a blade flies off while they are in the field? What if something hits the blade and goes flying (like a bird)? What if it was YOUR kids and grandkids out there when something happened? I'm sure we will hear the "that will never happen" comeback BUT when it comes to your kids and their safety, you can't help but worry about the what-ifs. And just in the past few months, we have seen MANY of our biggest "what-if" fears playing out all over the country. Although these may be "rare" occurrences, when it comes to our family, we will not chance it!

Plus, from a financial perspective, these turbines will not only devalue our property but they are not cost effective. Would they build these turbines if they weren't subsidized with our tax dollars?

My husband actually contacted the OPSB when Republic Wind LLC released their revised project map because our home wasn't included. We made contact with Mr. Matt Butler of the OPSB and made him aware of the situation. He had made the proper contacts and the project maps were updated with our home location on it. However, recently we noticed that our home wasn't included on the sound study maps (found on OPSB website as Notice of Project Modifications and Project Information Update) that were given to the OPSB on June 28, 2019 from Republic Wind LLC and we are questioning the integrity of their studies due to the fact that they neglected to place our home on the map yet again with our home proximity being so close to a turbine site. Apex is aware of our home location due to the fact that they approached us asking us to sign a good neighbor agreement, which of course we declined. Please see the attached sound study maps that were taken from the OPSB website in regards to Case # 17-2295-EL-BGN: Republic Wind Farm.

We could continue on with facts about people abandoning their homes because no one would even consider buying their homes due to the noise and view. We could discuss the agricultural aspects, the danger for firefighters lives if one of these catches fire and falls, the harm they will cause to bats, bald eagles and other birds, the affects they will have on Air Ambulance accessibility and aerial crop spraying but let's just end with this. Or we could discuss one of the biggest concerns for the area: The Karst formation that is found in our area and how any disruption in the fragile system with large construction could have detrimental effects on our wells and drinking water.

The sad fact is that even though we oppose the wind farm, even though we chose not to sign the lease with Apex, we will still have to worry about these monstrosities affecting and infringing on our property if the project continues. OUR property that we worked very hard to acquire and build into the farm and homestead that it is today!

Thank you for your time and consideration in this matter. We hope that as you make your decision and vote on this very important matter that will affect so many community members and voters, that you make an educated decision based on facts as well as the voice of the community and not solely based on the enticement of financial gains.

In conclusion, our family asks you NOT to approve the Republic Wind, LLC. project in Sandusky and Seneca Counties.

Thank you for your time and consideration.

Sincerely,

Tom Maike

Jackie M. Maike

Tom & Jackie Maike,
2627 County Road 276
Bellevue, OH 44811

"one person can make a difference, and everyone should try" – John F. Kennedy

Our Home Location (Not on map)

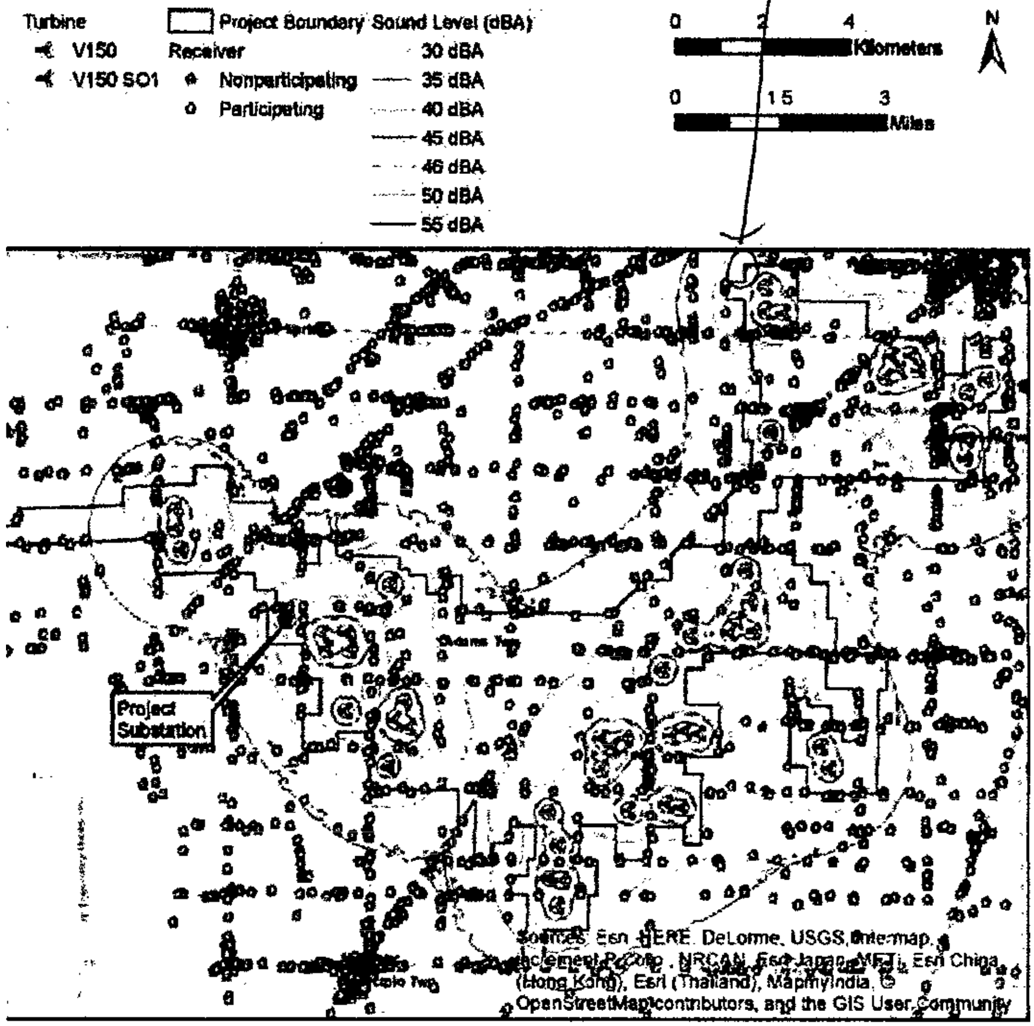


FIGURE 42: SOUND PROPAGATION MODELING RESULTS – VESTAS V150 4.2 MW

Our Home Location (Not on map)
2627 CR 276
Bellevue, OH

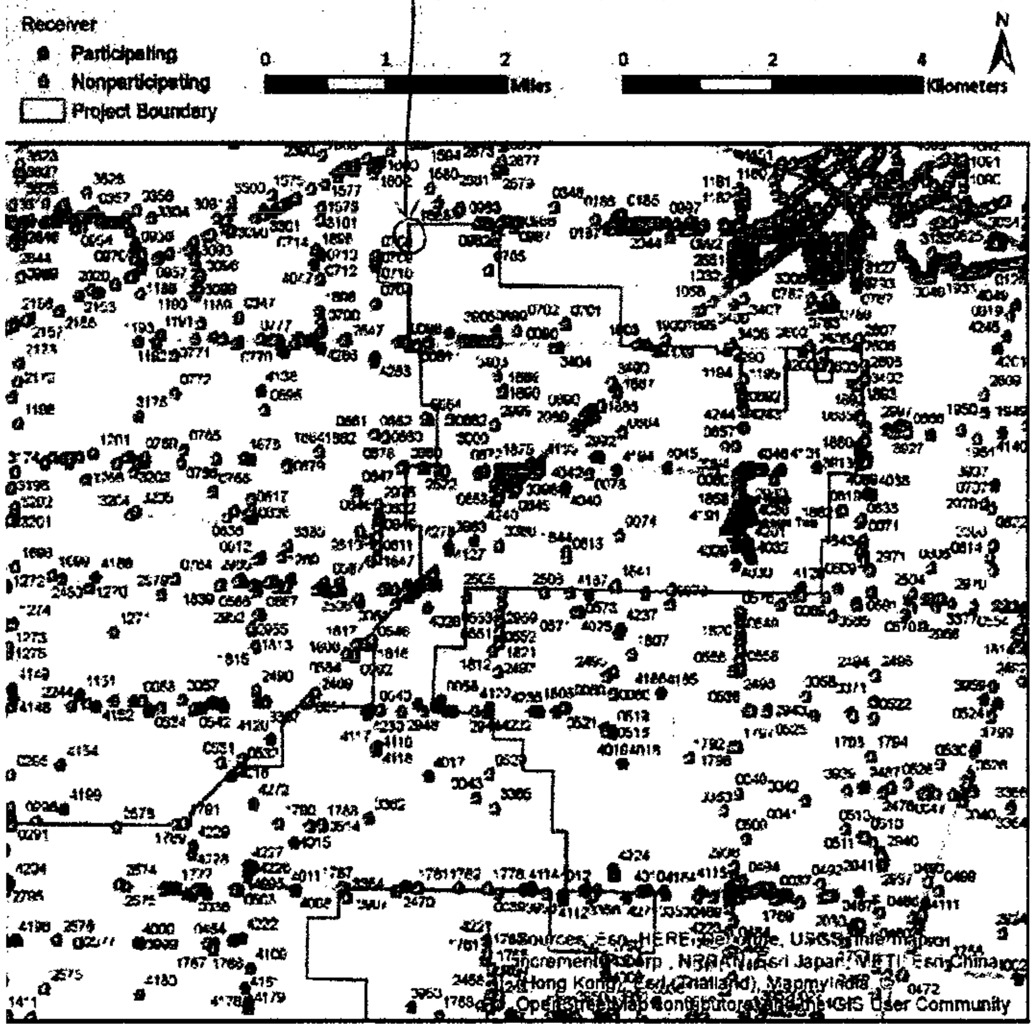


FIGURE 56: RECEIVER LOCATIONS - NE QUADRANT

Receiver ID	Status	Sound Pressure Level (dBA)						Coordinates (Ohio State Plane North)		
		Vestas V150 4.2 MW	Siemens SG4.5-145	Nordex N149 4.5 MW	Vestas V150 5.6 MW	Nordex N149 4.8 MW	Vestas V136 3.6 MW	X (m)	Y (m)	Z (m)
700	Nonpart.	33	33	33	32	32	32	564274	176738	242
701	Nonpart.	39	37	37	37	37	37	567531	176804	243
702	Nonpart.	39	37	37	37	37	37	567520	176807	243
703	Nonpart.	34	33	33	32	32	33	564248	176819	242
704	Nonpart.	39	38	38	38	38	38	564986	177069	244
705	Nonpart.	45	44	44	44	44	44	566498	177532	240
706	Nonpart.	27	27	27	26	26	27	574068	174167	245
707	Nonpart.	30	30	30	29	29	30	573291	174662	247
708	Nonpart.	39	38	38	38	37	38	564992	177732	241
709	Nonpart.	39	38	38	38	37	38	564987	177673	242
710	Nonpart.	39	38	38	38	37	38	564992	177632	242
711	Nonpart.	39	38	38	38	37	38	564983	177580	242
712	Nonpart.	34	33	33	33	32	33	564243	177415	242
713	Nonpart.	33	33	33	32	32	32	564251	177750	242
714	Nonpart.	33	33	32	32	31	32	564192	177747	242
715	Nonpart.	29	29	28	28	27	28	571317	178657	233
716	Nonpart.	29	29	29	28	28	28	571248	178595	232
717	Nonpart.	29	28	28	28	28	26	571195	178523	228
718	Nonpart.	26	25	25	24	24	23	571123	178462	229
719	Nonpart.	29	28	28	28	27	27	571072	178390	233
720	Nonpart.	30	29	29	29	29	29	571056	178365	235
721	Nonpart.	30	30	30	29	29	29	571039	178339	235
722	Nonpart.	31	30	30	29	29	30	571015	178311	234
723	Nonpart.	31	30	30	30	29	30	570962	178239	233
724	Nonpart.	31	30	30	30	29	29	570911	178181	233
725	Nonpart.	31	31	30	30	30	30	570867	178132	234
726	Nonpart.	32	31	31	30	30	30	570842	178101	235
727	Nonpart.	31	30	30	30	29	29	570816	178065	236
728	Nonpart.	32	31	31	31	30	31	570724	178004	238
729	Nonpart.	29	28	28	28	27	28	570744	178987	235
730	Nonpart.	29	29	28	28	27	28	570778	178938	236
731	Nonpart.	29	29	28	28	27	28	570811	178910	236
732	Nonpart.	29	29	28	28	27	28	570842	178877	236
733	Nonpart.	29	29	28	28	27	28	570852	178866	236
734	Nonpart.	29	29	28	28	28	28	570885	178838	236
735	Nonpart.	29	28	28	28	27	27	570939	178800	235
736	Nonpart.	29	28	28	28	27	28	570952	178782	235

Receiver ID	Status	Sound Pressure Level (dBA) Vestas V150 4.2 MW	Siemens SG4.5-145	Nordex N149 4.5 MW	Vestas V150 5.6 MW	Nordex N149 4.8 MW	Vestas V136 3.6 MW	Nordex N149 5.5 MW	Nordex N149 5.7 MW	Coordinates (Ohio State Plane North) X (m)	Y (m)	Elevation + Receiver Height (m)
701	Nonpart.	39	39	39	39	39	38	38	39	567531	176804	243
702	Nonpart.	39	39	39	39	39	38	38	39	567520	176807	243
703	Nonpart.	34	34	34	34	34	34	33	33	564248	176819	242
704	Nonpart.	39	40	40	39	40	39	38	39	564986	177069	244
705	Nonpart.	45	46	46	45	46	45	45	45	566498	177532	240
706	Nonpart.	27	29	28	28	28	28	27	27	574068	174167	245
707	Nonpart.	30	32	31	31	31	31	30	30	573291	174662	247
708	Nonpart.	39	39	39	39	39	39	38	39	564992	177732	241
709	Nonpart.	39	39	39	39	39	39	38	39	564987	177673	242
710	Nonpart.	39	39	39	39	39	39	38	39	564992	177632	242
711	Nonpart.	39	40	39	39	39	39	38	39	564983	177580	242
712	Nonpart.	34	34	34	34	34	34	33	34	564243	177415	242
713	Nonpart.	33	34	34	33	34	33	32	33	564251	177750	242
714	Nonpart.	33	34	33	33	33	33	32	33	564192	177747	242
715	Nonpart.	29	30	29	29	29	29	28	29	571317	178657	233
716	Nonpart.	29	30	30	30	30	30	29	29	571248	178595	232
717	Nonpart.	29	30	30	30	30	27	29	29	571195	178523	228
718	Nonpart.	26	26	26	26	26	25	25	26	571123	178462	229
719	Nonpart.	29	29	29	29	29	28	28	29	571072	178390	233
720	Nonpart.	30	31	31	30	31	30	30	30	571056	178365	235
721	Nonpart.	30	31	31	31	31	31	30	30	571039	178339	235
722	Nonpart.	31	31	31	31	31	31	30	31	571015	178311	234
723	Nonpart.	31	32	31	31	31	31	30	31	570962	178239	233
724	Nonpart.	31	32	31	31	31	30	30	31	570911	178181	233
725	Nonpart.	32	32	32	32	32	32	31	31	570867	178132	234
726	Nonpart.	32	32	32	32	32	31	31	32	570842	178101	235
727	Nonpart.	31	31	31	31	31	30	30	31	570816	178065	236
728	Nonpart.	32	33	33	32	33	32	31	32	570724	178004	238
729	Nonpart.	29	30	29	29	29	29	28	29	570744	178987	235
730	Nonpart.	29	30	29	29	29	30	28	29	570778	178938	236
731	Nonpart.	29	30	29	29	29	30	28	29	570811	178910	236
732	Nonpart.	29	30	30	29	30	30	28	29	570842	178877	236
733	Nonpart.	29	30	30	29	30	30	28	29	570852	178866	236
734	Nonpart.	29	30	30	29	30	30	28	29	570885	178838	236

Our home Location
(Not on map)

2627 CR 276
Bellevue, OH 4481

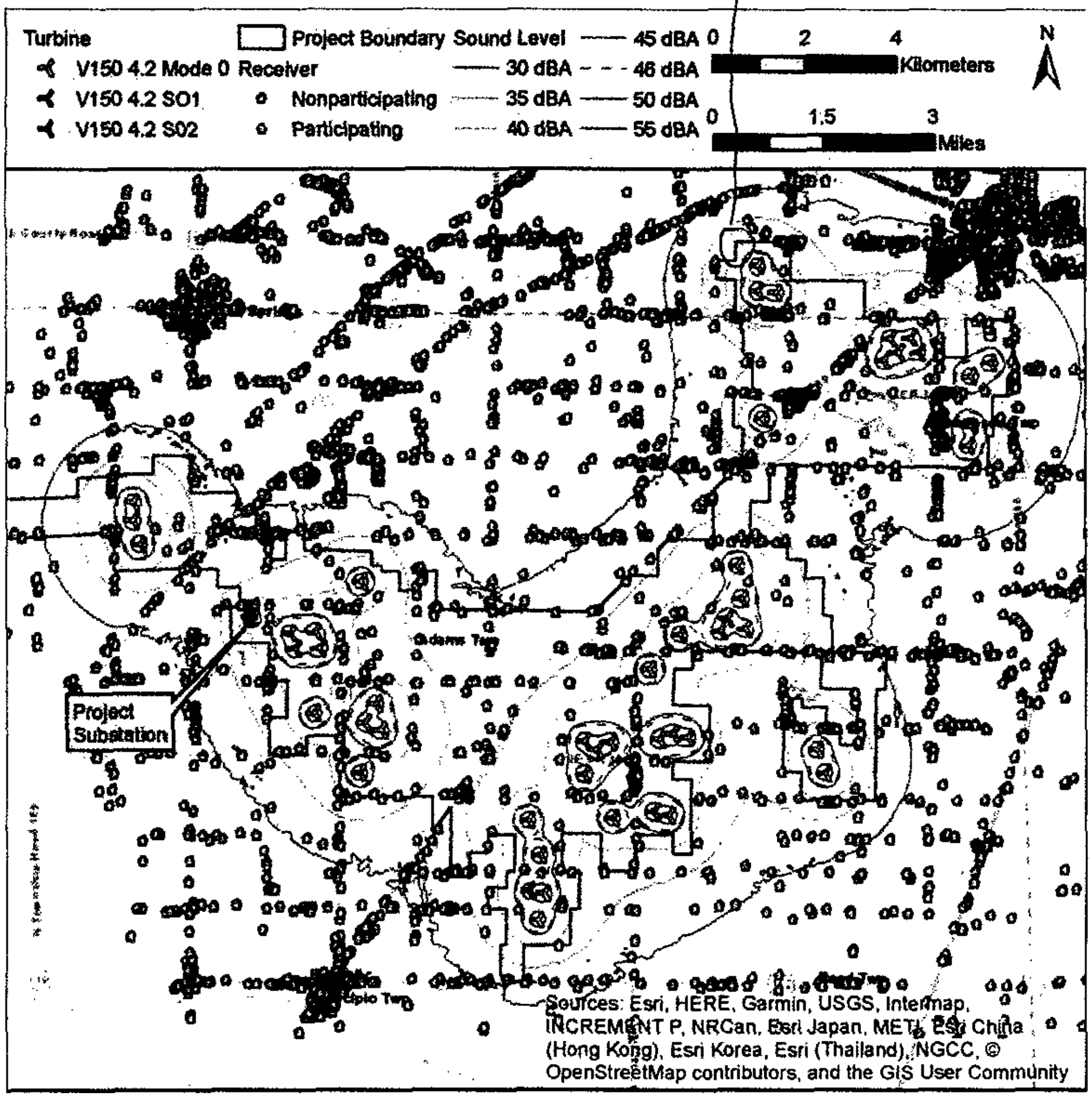


FIGURE 2: SOUND PROPAGATION MODELLING RESULTS AT CRITICAL DESIGN WIND SPEED - VESTAS V150 4.2 MW

Our home location
(Not on Map)

2627 CR 276
Bellevue, OH 44811

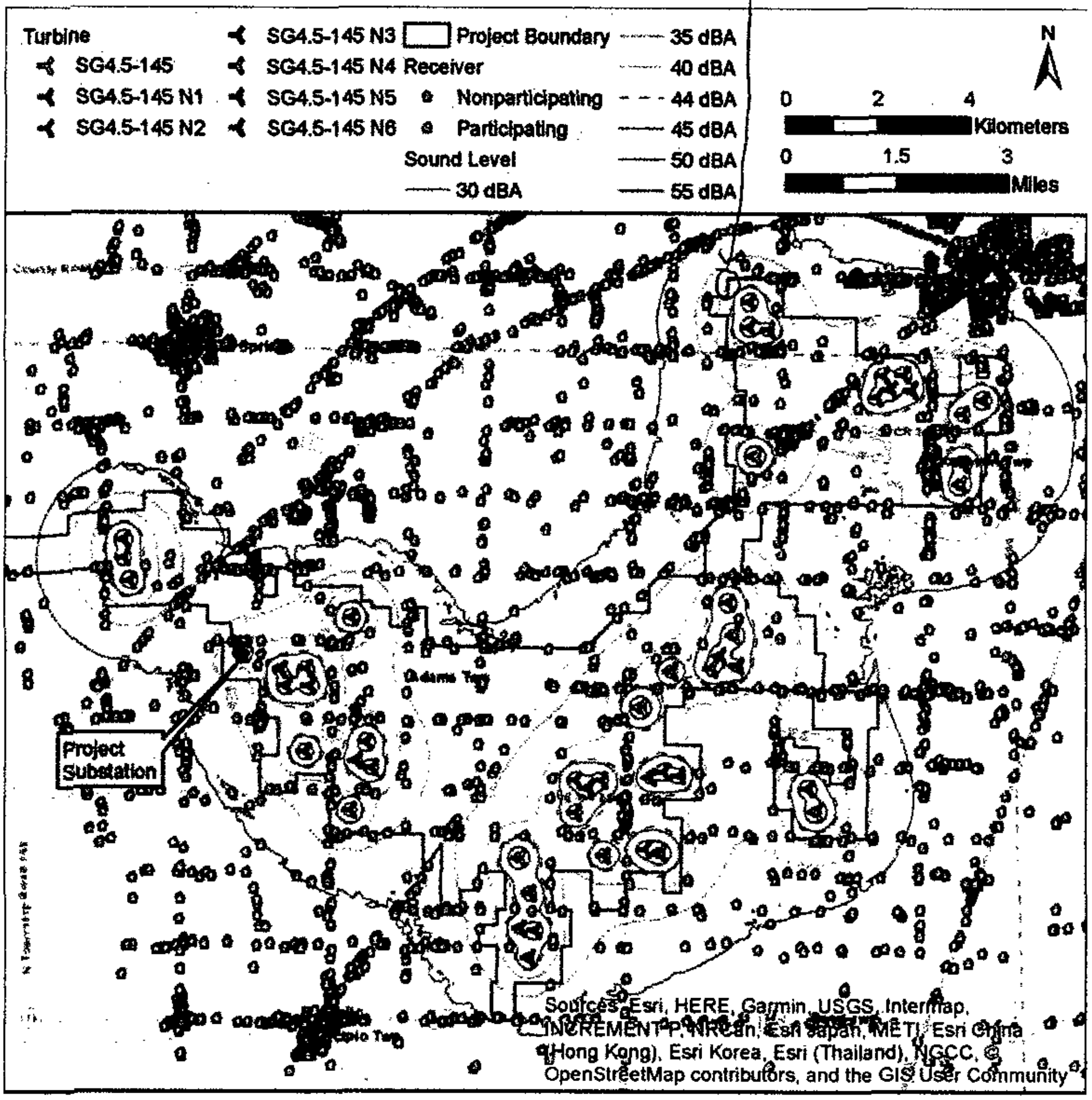


FIGURE 3: SOUND PROPAGATION MODELING RESULTS AT CRITICAL DESIGN WIND SPEED - SIEMENS SG4.5-145

OD's home location
(Not on map)

2627 CR 276
Bellevue OH 44811

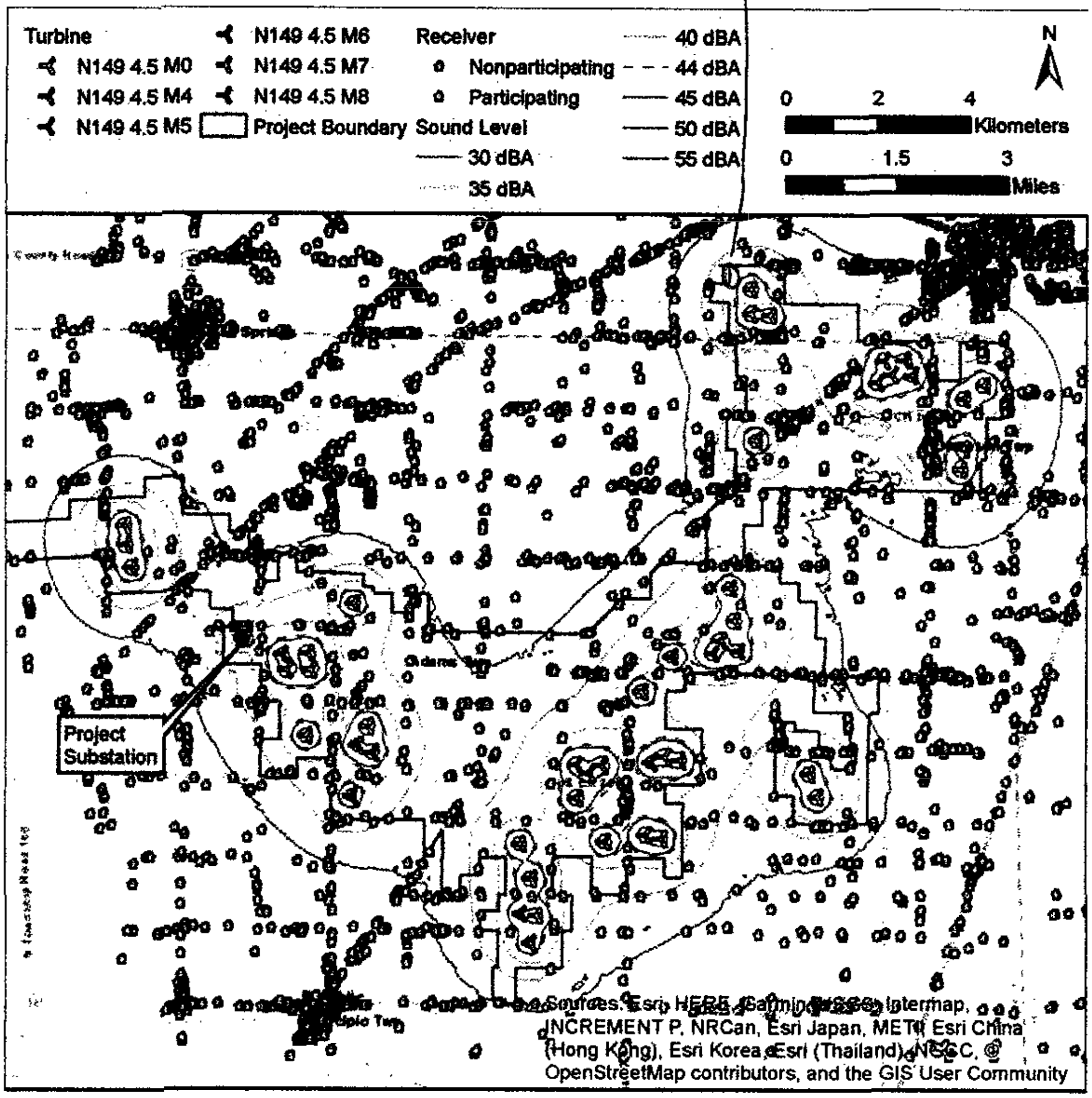


FIGURE 4: SOUND PROPAGATION MODELING RESULTS AT CRITICAL DESIGN WIND SPEED - NORDEX N149 4.5 MW

Our Home Location
(Not on map)

2627 CR 276
Bellevue, OH 44811

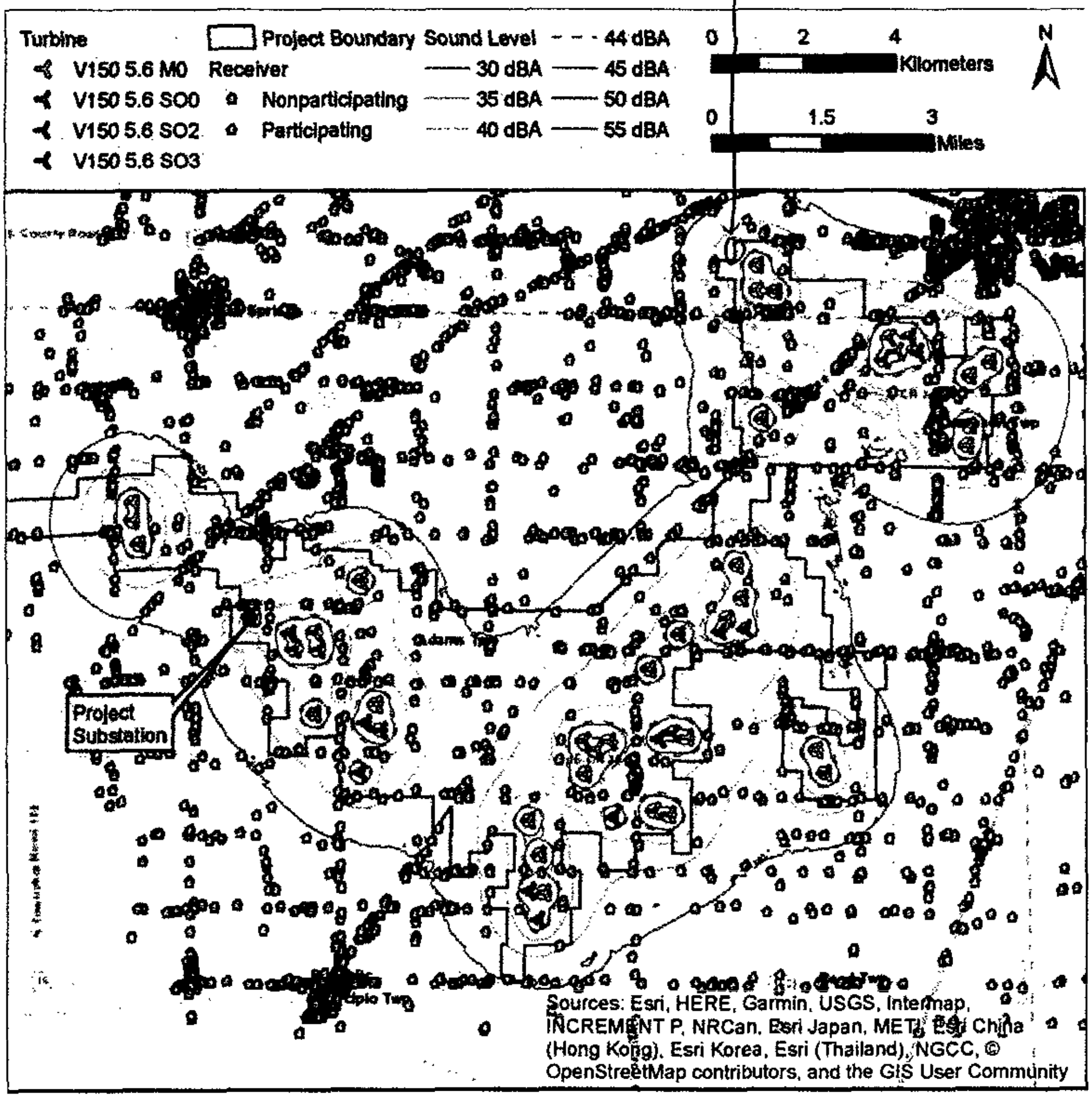


FIGURE 5: SOUND PROPAGATION MODELING RESULTS AT CRITICAL DESIGN WIND SPEED - VESTAS V150 5.6 MW

Our Home Location
(Not on Map)

2627 CR 276
Bellevue OH 44811

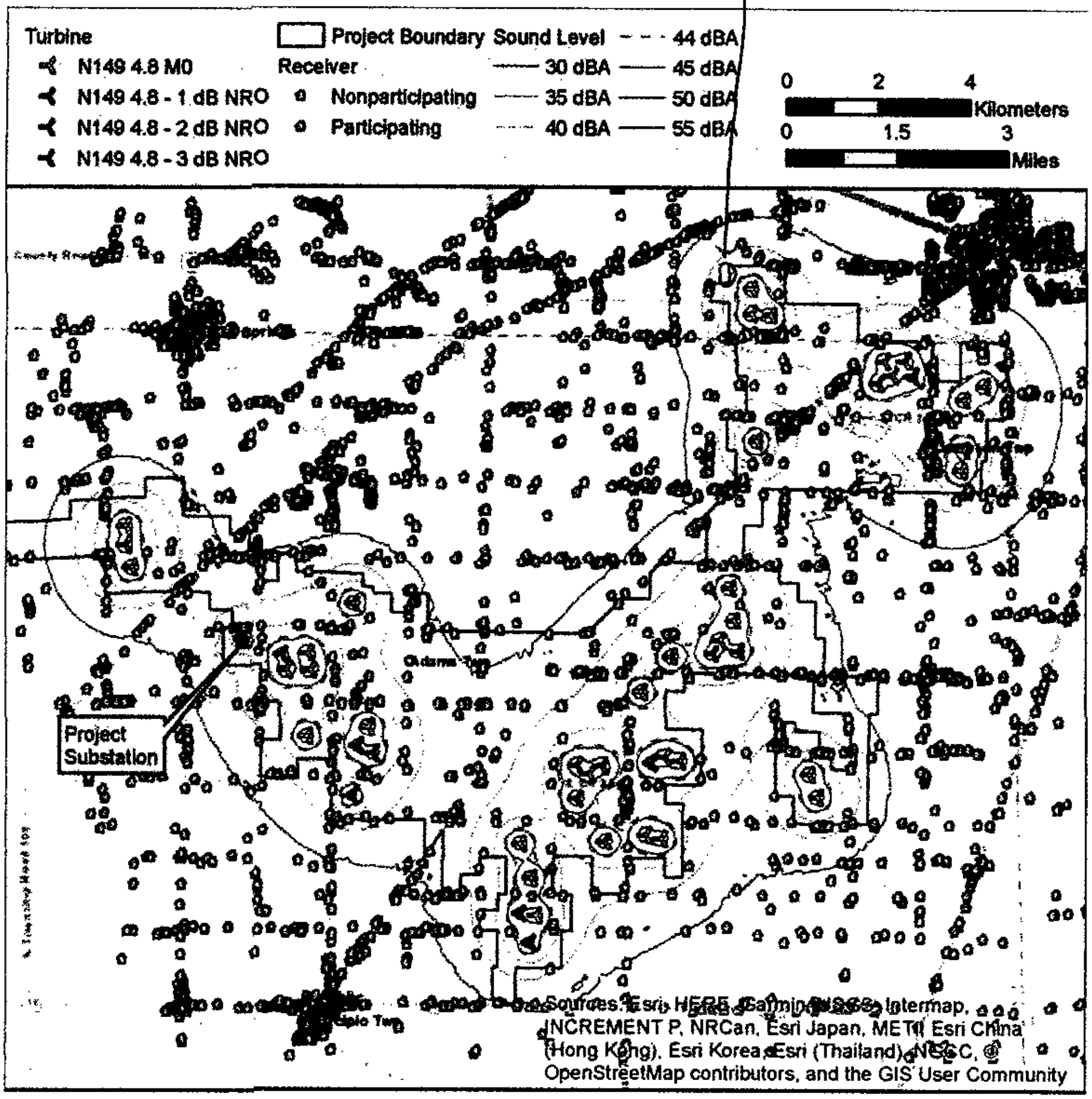


FIGURE 6: SOUND PROPAGATION MODELING RESULTS AT CRITICAL DESIGN WIND SPEED - NORDEX N149 4.8 MW

Our Home Location
(Not on Map)

2627 CR 276
Bellevue OH 44811

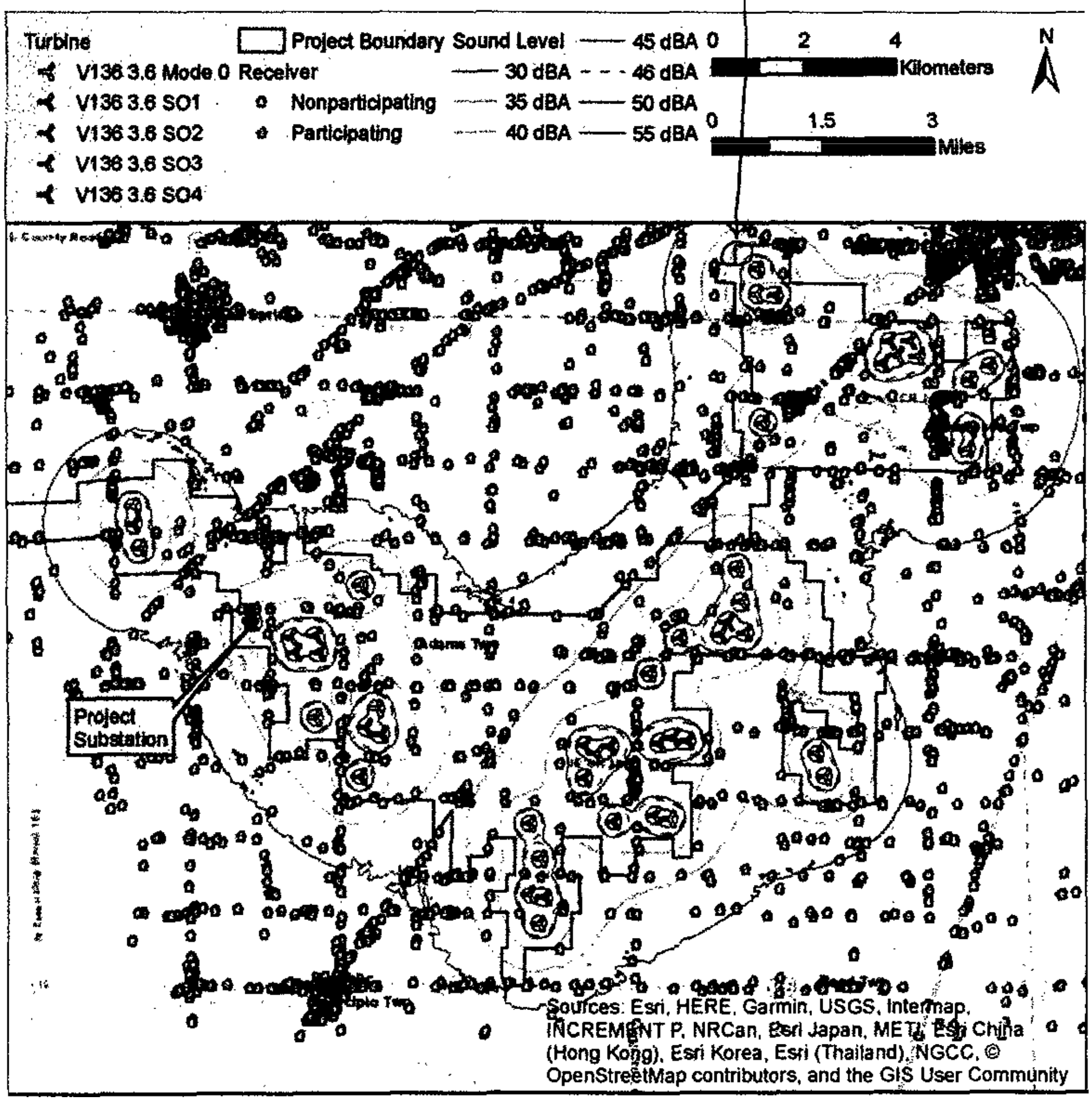


FIGURE 7: SOUND PROPAGATION MODELING RESULTS AT CRITICAL DESIGN WIND SPEED - VESTAS V136 3.6 MW

17-2295-EL-BGN

Thank you for your Time...
OHIO Power Siting Board
I'm a Resident of seneca County, a property
owner and Residing in Clinton Twp. and a
property owner in Eden Twp. as well.
I'm writing this because I've recently lost
my voice and having trouble speaking
I would like to start out saying that I
strongly oppose the wind farms in our populated
rual area.
My Wife Penny and I purchaced our 15 acre
property in Eden TWP. 3 years ago to build our
final Home and finish raising our expanded family our
property tends to our Wildlife loving family with
a fine acre woods, that we have planted fruit trees,
and have corn feeders, salt blocks for our Deer. Plans
for a Pond behind our House for Drinking.
We were allready to sign the Dotted line
and approve our plans to Break ground on our new
House when, we got a awful letter from a Attorny
Saying "Seneca Wind is coming your Way!"......
Sooooo. Since then my family has been making
Do with our Residence in Clinton twp. The land
purchase was made because We Recently Adopted 2
Brothers we've had since Birth one 3 years and other
is two years old now. with our two Biologicals giving 4 Boys
all together

over please

Randy Kuhn 1099 E. Co Rd 50 Tiffin OH 44883

Getting to the Point.....
I could not afford any more property value loss by building a House on a property that was scedualed on a map to have a 600 ft plus Turbine behind it. the posibility of flicker/flash, ground water Issues, Noise, Infrasound, and the rest of the "good niebor" stuff.
So at this moment my house and 2 more Homes one on Hold that I know of for sure in Eden twp alone because of these wind farm threats. that tax revenue that is in holding for Eden Twp.
finally... would like to finish with the Horobble Lying Tackics the sales reps told me everyone around me signed and if I didn't I would be screwing them over so, I called them that night they were all outraged, Mrs. Kuhn turned Down the lunch offer that the sales lady told me they had. (She told me they had a nice little lunch.) Lie!
I was contacted one last Time with a 15 thousand dollar Hand shake and a 2 thousand Dollar a year Good niebor Payment for thirty years
I said **NO!**

thank you
Randy Kuhn

17-2295-EL-BGN

September 12, 2019

Republic Wind, LLC

OPSB Public Hearing

OPSB# 17-2295-EL-BGN

Dear Members of the Board,

My name is Rick Coffman. I reside at 3220 East County Road 6, Tiffin, OH., Seneca County. As a life long resident in this county for over 61 years, I am opposed to any wind turbine project of this magnitude in such a densely populated area. The proven negative affects that impact human lives by this type of project are many. Many Seneca County residents have poured their heart and soul into their homes and property, as well as building a heritage for a life time. It is an investment for life, not to be trifled with.

An approval of the Republic Wind project would be an affront to all county residents. It would in effect force many to change their daily lives in tremendous ways to accommodate this project. This is a social experiment that should not be permitted here or anywhere without the direct consent of those impacted. Additionally, to permit this project would open the door to other projects in the immediate area. Once again, Seneca County is far too populated for a project of this size. As you are well aware, the Ohio Power Siting Board is bound to do what is fair and just for the residents of the State of Ohio.

Please consider this letter as an official notification for the record against any approval of Republic Wind LLC's request for permitting to build in Seneca County. Thank you for your time and consideration in this matter.

Sincerely,

Rick Coffman

Rick Coffman

17-2295-EL-BGN

Dear Board,

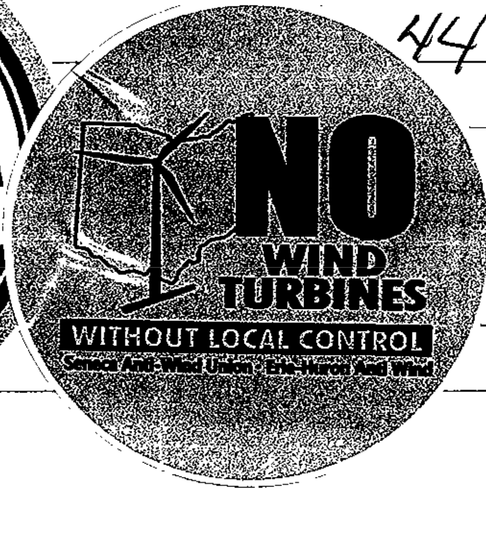
These Industrial wind turbines do not belong on our rural farm land! We need to save our farmland, not destroy it. Wherever these industrial turbines are placed, the land would never be able to be used for farming again.

This is just one of many, many reasons why these machines do not belong here.

Thank You,

Sandra Hiser

Seneca County, Ohio
6378 Twp. Rd. 151
Tiffin OH
44883



17-2295-EL-BGN

September 12, 2019

Subject: OPSB#17-2295-EL-BGN

Ohio Sighting Board,

My name is Mary E. Coffman. I live at 3220 E County Road 6, Tiffin, OH 44883 in Seneca County.

I want to say that I am happy I am not going to have Wind Turbines in my view anymore because Seneca Wind Project is no more.

I am writing to support the residents of the Republic Wind **against** Wind Turbines. I am sure they were tricked just as we were. I few residents, lease holders, knew and the rest did not.

I do not want **any** wind turbines in Seneca County at all. This is a residential county and Republic Wind needs to understand this is no different than the Seneca Wind Project. All the arguments and reasons are the same. Seneca County is residential and agriculture. We do not want Wind Turbines.

Thank you for your time,

Mary E. Coffman

Mary E. Coffman

Submitted by Kimberly Groth
Address: 5245 S. Co. Rd. 43, Bloomville, OH

17-2295-EL-BGN

Next month will mark 10 years since my husband and I bought our home. It is an 1840's stone farmhouse that we purchased at sheriff sale and spent the next nine months renovating before moving in the following June. It was a dream come true for me, not only because of the house but because of the whole package – the tree lined creek, the open fields, the sunsets and the wildlife, the quiet. The history in the house drew me from the start, but there are plenty of old houses in town that we never even considered buying. The property we did buy combined the perfect house with the perfect setting; it was a wonderfully intact historic home in a rural and agricultural setting. It was exactly what I wanted. (And my husband, bless him, was willing to come along for the ride.) There's no pizza delivery to our house, cell phone service can be spotty and high speed internet options limited, certain times of the year we expect to be stuck behind slow-moving farm machinery, and some days we can smell the new livestock barn built south of our home. We expected all of those inconveniences when we moved here. But we never expected our home could be in the middle of an industrial energy complex that would change the light, the sound, and the view. In short, industrial wind could take away many of the reasons we chose to live here in the first place.

Home is supposed to be your sanctuary. It's hard to explain what it does to you when the place that has been your respite is suddenly the constant source and reminder of your stress.

Coming home from work and immediately noticing that the kids turned off the TV when they were done playing video games but once again forgot to turn off the old Xbox 360. The sound of the disk still spinning has always annoyed me. It's not that it's overly loud, but the noise is grating and irritating to me. My husband measured that sound last summer at 37 decibels. Estimated wind turbine noise at our house will be 41-44 decibels. And I won't be able to turn it off.

Appreciating a beautiful sunset and turning to my husband to say, "Look at that beautiful sun - " but stopping mid-sentence with the realization that this is the exact time of day we will have shadow flicker once the turbines are built.

Setting outside in the early evening while the kids count fireflies and I watch the bats that live on our property as they fly out into the night. But now, all the while wondering if I sit outside in future evenings, how many fewer bats will I count?

Avoiding a familiar route so I don't have to see the painfully slow process of removing a scenic tree line. Wondering every time I do pass how much more destruction will follow as narrow rural roads are widened to accommodate massive industrial machinery.

Sitting beside pro-wind State Senator, Matt Dolan, at a meeting in Tiffin last fall and hearing him openly acknowledge that the wind industry would be a "burden" on this community. Burden – that was his word, not mine. And because the Dolan family are owners of the Cleveland Indians, and I have not even been able to watch or listen to a game yet this season that I haven't been reminded of industrial wind's shadow on my home and community.

Coming home late one night, getting out of the car and looking up at a stunning, starry night sky. But then remembering that those intensely dark night skies may soon be dotted with hundreds of blinking red lights in all directions.

Getting a call from the architect we contacted a year ago, meeting with him and getting his plans for the addition we have anticipated ever since buying this home a decade ago. But feeling pain whenever I glance at his rolled up plans, because I know it makes no sense to invest the money we have been working so hard to save on a house we might soon choose to leave.

My dad has asked me, "Where would you go?" and sadly, it's a good question. This area is my home, and has been home since my ancestors moved here in the 1830's. Our house is in the Seneca Wind footprint, but the project we are discussing here, Republic Wind, is one of multiple other projects that stand to scar the rural landscape for miles. How far away would we have to move to not be in the shadow of these projects? And would we be able to sell our home for the same price it would have drawn two years ago? When it comes to property values, to me the question is not ***if*** wind projects decrease property values but instead ***how much*** do they decrease property values?

I am aware that some local landowners are willing to accept the changes to the rural landscape that would come with industrial wind development. But, in the words of State Senator Dave Burke, "Wind turbines are large objects which change a landscape beyond the property owner who holds them."[1] And therein lies the problem. A landowner can decide he is willing

1 "Rep. Reineke Flips on Setbacks,"Advertiser Tribune, Tiffin, Ohio; June 28, 2018

to sell his own property rights to an industrial wind company, but he should never have the ability to sell his neighbor's property rights.

Republic Wind has 50 proposed turbine locations. I've spent some time comparing Apex's maps to the Seneca County Auditor's on-line mapping system. By my study, there are 32 landowners represented by those 50 turbine locations. Compare that figure to the noise impact assessment filed by Apex which identifies 4,299 "receivers" in the Republic Wind footprint. In other words, 4,299 homes. Over 4,200 families who chose to live here, who chose to invest and build memories in a rural and agricultural community. Their expectation that this would remain a rural and agricultural community is not unreasonable.

32 households out of 4,299. That is 7/10th of one percent. Less than one percent. Technically, even less than that, because there are numerous absentee landowners counted in the 32.

It has been pointed out to this board before that the Ohio Constitution recognizes certain inalienable rights, among them the rights of "possessing and protecting property, and seeking and obtaining happiness and safety."[2] The Oxford Dictionary defines "inalienable" as "unable to be taken away", but I have to say that here in Seneca County that definition is feeling rather precarious right now.

You cannot lose something that you never had, so if this project ends the 32 cannot lose turbine lease payments that they never received. But if these turbines are built the 4,200 will lose something that you cannot put a price on. They will lose the rural landscape as they know it.

This board has many reasons to deny the Republic Wind project. Deny it because this area is too densely populated to host industrial wind. Deny it because of the extensive karst geology in the project's footprint. Deny it because of its location within a major migratory bird route. Deny it because there is no public need for the unreliable, intermittent energy it would produce. Deny it because you have concrete evidence that the setback distances would risk public safety. But beyond all of these reasons, in the absence of the Reineke Referendum, deny it because as members of the Ohio Power Siting Board you are currently the only people in this state with the ability to honor the pleas of the people who live in this community. And we are begging you with everything we have to say no.

Thank you for your time.

---

2 Ohio Constitution, I.01 Inalienable Rights

Opposition to Republic Wind LLC
OPSB # 17-2295-EL-BGN

Dennis Daniel
5285 Old Military Rd.
Willard, Ohio 44890

To the Ohio Power Siting Board,

Although I do not live in the project area of Republic Wind LLC OPSB #17-2295-EL-BGN, I am opposed to the project's approval due to its close proximity to the Emerson Creek Firelands Wind LLC OPSB# 18-1607-EL-BGN area in which I do live.

I have been presented no evidence that there is a public need for this project to be built in Seneca and Sandusky Counties nor a public need in the State of Ohio. There is no evidence that this wind project will take the place for the need of fossil fuel powered power generating plants in Ohio.

The Republic Wind LLC project will have a negative impact on non participating land owners by lowering property values and diminishing the quality of living in our rural townships. The project area is too densely populated for the proposed number of industrial wind turbines that may tower over 600 feet tall.

The height of the industrial wind turbines will negatively impact air services such as air ambulance and air crop service. This will deprive area citizens of timely medical treatment and it will adversely affect area farmers who depend on air services for the planting and spraying of crops.

The approval of the Republic Wind LLC project will also have a negative impact on the health of citizens residing in the proposed project area. Blade failure, ice throw, shadow flicker, turbine noise will jeopardize the health and safety of residents living among the industrial wind turbines. Not only will the health and safety of humans be put at risk but wildlife such as birds and bats will die because of the construction of industrial wind turbines.

It is because of the stated reasons that I oppose the approval of the Republic Wind LLC, OPSB # 17-2295-EL-BGN, industrial wind turbine project.

Signed,
Dennis S. Daniel

SAWU Docket # 17-2295-EL-BGN

Jean Roth
14230 E. Seneca CR 34
Bellevue, OH 44811
(lived here 33 years)

Quality of Life:

As I get older, the term, "Quality of Life," becomes a topic more frequently discussed.

Since Seneca Wind LLC made plans to build wind turbines in Seneca County, I think my "Quality of Life" will be diminished. My house and yard (1 acre) will become another statistic.

I will be part of:

1. 103 inhabitants residing in 44 homes per sq. mile - with wind turbines in neighbors' yards
2. loss of rural landscapes
3. shadow flickers
4. continuous sound > 45 dB - causes diminished health

Continued:
page 2

Jean Roth
docket #17-2295-EL-BGN

9 months ago, I travelled from Williams, AZ, by train to the Grand Canyon. I did see some wind turbines, but not many houses. North of Williams there is a Perrin Ranch Wind Farm (2012) containing 62 turbines - 398 feet tall. By a picture of this, a comment was made that the "turbines dwarf construction trucks and workers." Imagine what would be said with our 492-602 feet tall turbines.

In AZ, there are neighbors vs. state concerning windmills. The neighbors are wondering what the view along the drive to the Grand Canyon should include. What do you think? Windmills?

At this Perrin Ranch:
Power Generation - could power 29,000 homes when running at peak capacity
② In reality - when running at average/typical generation - could power an estimated -8,700 homes.
(a difference of 20,300 homes) 30%

Continued:
page 3

Jean Roth
docket #17-2295-EL-BGN

When all is said and done, 30% efficiency doesn't seem to be high enough to disrupt my health, neighboring landscapes, and my life.

I would hope the "Quality of Life" would be expected to get better not worse for me and my family.

I challenge the Seneca Wind LLC to picture their own neighborhoods with 600 feet tall wind turbines. If the turbines don't seem to fit in your picture, maybe land in the middle of nowhere, would be better suited, than land filled with homes and people.

Thank You!

To the Ohio Power Siting Board ,   Republic Wind 17-2295-EL-BGN

I am a non participating property owner in the middle of 3 proposed Industrial wind projects in this area . I am concerned about the physical , mental , and social well being of my family and that of the many non participating members in our area and some of the contract holders . I would like compare these wind companies to the Pharmaceutical commercials you folks have all seen on TV . You know when they tell you about the drug they want you to ask your Doctor about . Then they list the possible side effects which may include , dizziness, headache, nausea, indigestion, vomiting, internal bleeding , and the list goes on . Makes you want to go right out and buy some doesn't it ? Well the Industrial Wind people are telling you sort of the same thing , but they tell you right up front in their reports and in their contracts some of the things that are definitely going to happen when these things are in use . They have told you, there will be noise and infrasound , shadow flicker , blade failures , flashing red lights , ice throws ,visual effect, damage to the roads , colverts, and tile, that they will kill raptors , bats , song birds . They are telling you this , you have the maps showing you where , and you can see the the dark colored blue dots , lots of them , those are non participants . On any of the above including shadow flicker the acceptable amount on to a non participants property should be 0% . These are very very large heavy Industrial Machines that are spinning blades that weighs many tons. , and common sense tells us the rest of the story, that they shouldn't have to tell you . The possible, and most likely side effects will be, toppling of these machines , fires , major oil leaks , failure of the bearings , blade throws ,vibration , well contamination, doppler radar interference , loss of property value . You do not need to be a Scientist or Doctor to see what is going to happen. I would guess that you already know, serious harm to human health includes indirect impacts from exposure to noise , flicker , and ear pressure which in turn can cause stress, stress alone leads to other

Frank Bishop

possible side effects , vertigo, anxiety, sense of injustice, sleep disturbance ,depression, dizziness . All possible side effects .... But you folks are here to protect me and all of these fine folks who are non participants and keep us safe from this sort of thing , we can choose not to buy the pharmaceutical drug if we don't like the side effect, but we do not currently get to choose if Industrial wind is safe for our community. The State of Ohio can tell us,..that we have to live with them for the next 30 or more years.... , and tough luck on the possible side effects, and that is Not Right ! I would please urge you protect the citizens of this Great State of Ohio , I feel you will do the right thing , I have included the opinion of 3 family physicians who have treated people who live within these projects . Thank you for listening and for your time .

Frank Bishop   Frank Bishop

Norwich Twp

Willard , Ohio 44890

Emerson Creek footprint Resident

Frank Bishop.
6325 Scottwood Rd
Willard Ohio 44890

17-2295-EL-BGN

Adverse health effects of industrial wind turbines

Roy D. Jeffery MD FCFP Carmen Krogh Brett Horner CMA

Canadian family physicians can expect to see increasing numbers of rural patients reporting adverse effects from exposure to industrial wind turbines (IWTs). People who live or work in close proximity to IWTs have experienced symptoms that include decreased quality of life, annoyance, stress, sleep disturbance, headache, anxiety, depression, and cognitive dysfunction. Some have also felt anger, grief, or a sense of injustice. Suggested causes of symptoms include a combination of wind turbine noise, infrasound, dirty electricity, ground current, and shadow flicker.[1] Family physicians should be aware that patients reporting adverse effects from IWTs might experience symptoms that are intense and pervasive and might feel further victimized by a lack of caregiver understanding.

Background

There is increasing concern that energy generation from fossil fuels contributes to climate change and air pollution. In response to these concerns, governments around the world are encouraging the installation of renewable energy projects including IWTs. In Ontario, the Green Energy Act was designed, in part, to remove barriers to the installation of IWTs.[2] Noise regulations can be a considerable barrier to IWT development, as they can have a substantial effect on wind turbine spacing, and therefore the cost of wind-generated electricity.[3] Industrial wind turbines are being placed in close proximity to family homes in order to have access to transmission infrastructure.[4]

In Ontario and elsewhere,[5] some individuals have reported experiencing adverse health effects resulting from living near IWTs. Reports of IWT-induced adverse health effects have been dismissed by some commentators including government authorities and other organizations. Physicians have been exposed to efforts to convince the public of the benefits of IWTs while minimizing the health risks. Those concerned about adverse effects of IWTs have been stereotyped as "NIMBYs" (not in my backyard).[6,7]

Global reports of effects

During the past few years there have been case reports of adverse effects. A 2006 Académie Nationale de Médecine working group report notes that noise is the most frequent complaint. The noise is described as piercing, preoccupying, and continually surprising, as it is irregular in intensity. The noise includes grating and incongruous sounds that distract the attention or disturb rest. The spontaneous recurrence of these noises disturbs the sleep, suddenly awakening the subject when the wind rises and preventing the subject from going back to sleep. Wind turbines have been blamed for other problems experienced by people living nearby. These are less precise and less well described, and consist of subjective (headaches, fatigue, temporary feelings of dizziness, nausea) and sometimes objective (vomiting, insomnia, palpitations) manifestations.[8]

A 2009 literature review prepared by the Minnesota Department of Health[9] summarized case reports by Harry (2007),[10] Phipps et al (2007),[11] the Large Wind Turbine Citizens Committee for the Town of Union (2008),[12] and Pierpont (2009).[13] These case studies catalogued complaints of annoyance, reduced quality of life, and health effects associated with IWTs, such as sleeplessness and headaches.[9]

In 2010, Nissenbaum et al used validated questionnaires in a controlled study of 2 Maine wind energy projects. They concluded that "the noise emissions of IWTs disturbed the sleep and caused daytime sleepiness and impaired mental health in residents living within 1.4 km of the two IWT installations studied."[14]

Reports of adverse health effects[15] and reduced quality of life[16] are also documented in IWT projects in Australia and New Zealand.

A 2012 board of health resolution in Brown County in Wisconsin formally requested financial relocation assistance for "families that are suffering adverse health effects and undue hardships caused by the irresponsible placement of industrial wind turbines around their homes and property."[17]

An Ontario community-based self-reporting health survey, WindVOiCe, identified the most commonly reported IWT-induced symptoms as altered quality of life, sleep disturbance, excessive tiredness, headache, stress, and distress. Other reported effects include migraines, hearing problems, tinnitus, heart palpitations, anxiety, and depression.[18] In addition, degraded living conditions and adverse socioeconomic effects have been reported. In some cases the effects were severe enough that individuals in Ontario abandoned their homes or reached financial agreements with wind energy developers.[19]

This article has been peer reviewed.

La traduction en français de cet article se trouve à www.cfp.ca dans

After considering the evidence and testimony presented by 26 witnesses, a 2011 Ontario environmental review tribunal decision acknowledged IWTs can harm human health:

> This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree.[20]

Indirect effects and annoyance

When assessing the adverse effects of IWTs it is important to consider what constitutes human health. The World Health Organization (WHO) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."[21]

Despite being widely accepted, the WHO definition of health is frequently overlooked when assessing the health effects of IWTs. Literature reviews commenting on the health effects of IWTs have been produced with varying degrees of completeness, accuracy, and objectivity.[22] Some of these commentators accept the plausibility of the reported IWT health effects and acknowledge that IWT noise and visual effects might cause annoyance, stress, or sleep disturbance, which can have other consequences. However, these IWT health effects are often discounted because "direct pathological effects" or a "direct causal link" have not been established. In 2010, the Ontario Chief Medical Officer of Health released *The Potential Health Impact of Wind Turbines,* which acknowledged that some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance but concluded "the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects."[23] The lead author of the report,[23] Dr Gloria Rachamin, acknowledged under oath that the literature review looked only at direct links to human health.[24]

Focusing on "direct" causal links limits the discussion to a small slice of the potential health effects of IWTs. The 2011 environmental review tribunal decision found that *serious harm to human health* includes "indirect impacts (e.g., a person being exposed to noise and then exhibiting stress and developing other related symptoms)."[20]

According to the night noise guidelines for Europe:

> Physiological experiments on humans have shown that noise of a moderate level acts via an indirect pathway and has health outcomes similar to those caused by high noise exposures on the direct pathway. The indirect pathway starts with noise-induced disturbances of activities such as communication or sleep.[25]

Pierpont documented symptoms reported by individuals exposed to wind turbines, which include sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering when awake or asleep.[13] The American Wind Energy Association and the Canadian Wind Energy Association convened a panel literature review that determined these symptoms are the "well-known stress effects of exposure to noise," or in other words, are "a subset of annoyance reactions."[26]

Noise-induced annoyance is acknowledged to be an adverse health effect.[27-30] Chronic severe noise annoyance should be classified as a serious health risk.[31] According to the WHO guidelines for community noise, "[t]he capacity of a noise to induce annoyance depends upon many of its physical characteristics, including its sound pressure level and spectral characteristics, as well as the variations of these properties over time."[32] Industrial wind turbine noise is perceived to be more annoying than transportation noise or industrial noise at comparable sound pressure levels.[33] Industrial wind turbine amplitude modulation,[34] audible low frequency noise,[35] tonal noise, infrasound,[36] and lack of nighttime abatement have been identified as plausible noise characteristics that could cause annoyance and other health effects.

Health effects in Ontario expected

Evidence-based health studies were not conducted to determine adequate setbacks and noise levels for the siting of IWTs before the implementation of the Ontario renewable energy policy. In addition, provision for vigilance monitoring was not made. It is now clear that the regulations are not adequate to protect the health of all exposed individuals.

A 2010 report commissioned by the Ontario Ministry of the Environment concludes:

> The audible sound from wind turbines, at the levels experienced at typical receptor distances in Ontario, is nonetheless expected to result in a non-trivial percentage of persons being highly annoyed .... [R]esearch has shown that annoyance associated with sound from wind turbines can be expected to contribute to stress related health impacts in some persons.[37]

Consequently, physicians will likely be presented with patients reporting health effects.

Family physicians should be aware that patients reporting adverse effects from IWTs might experience symptoms that are intense and pervasive and that they might feel further victimized by a lack of caregiver understanding. Those adversely affected by IWTs might have already pursued other avenues to mitigate the health effects with little or no success. It will be important to identify the possibility of exposure to IWTs in patients presenting with appropriate clinical symptoms.[38]

Conclusion

Industrial wind turbines can harm human health if sited too close to residents. Harm can be avoided if IWTs are situated at an appropriate distance from humans. Owing to the lack of adequately protective siting guidelines, people exposed to IWTs can be expected to present to their family physicians in increasing numbers. The documented symptoms are usually stress disorder–type diseases acting via indirect pathways and can represent serious harm to human health. Family physicians are in a position to effectively recognize the ailments and provide an empathetic response. In addition, their contributions to clinical studies are urgently needed to clarify the relationship between IWT exposure and human health and to inform regulations that will protect physical, mental, and social well-being.

Dr Jeffery is a family physician in the Northeastern Manitoulin Family Health Team in Little Current, Ont. **Ms Krogh** is a retired pharmacist and a former Editor-in-Chief of the Compendium of Pharmaceutical Specialties. **Mr Horner** is a Certified Management Accountant.

Competing interests

Dr Jeffery, Ms Krogh, and **Mr Horner** are on the Board of Directors for the Society for Wind Vigilance, an international federation of physicians, acousticians, engineers, and other professionals who share scientific research on the topic of health and wind turbines.

Correspondence

Dr Roy D. Jeffery, Northeastern Manitoulin Family Health Team, Box 549, Little Current, ON P0P 1K0; e-mail **jeffery_07@sympatico.ca**

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Repubic Wind 17-2295-EL-BG

Dear Ohio Power Sitng Board ,

I live in this area where these Industrial wind projects are being proposed .

I have major concerns about the safety of my Family and Friends who travel our Township roads to and from our home. Our roads were not designed to withstand Industrial traffic as is proposed to build these projects . You are talking about 1000s of trips made across the bridges and colverts of our Townships for industry . I would be very uncomfortable having my loved ones depending on these structures to hold up to this type of exposure . I would ask you this

Does the county engineer inspect these structures daily or after every truck crosses the structure ?

Who is responsible if one of our loved ones has a structure collapse under their vehicle ?

Who is responsible to take pictures under the structures before construction begins ? And after ?

How do you prove the structure was damaged by the heavy equipment that traveled across it during construction of the turbines ?

Can the Wind Company just say it is normal wear and tear ?

Is anyone responsible or do we just hold our breath when crossing these structures ?

Does this all fall back on a County that did not want industrial trucks on their township and county roads ?

Just asking, because I see heavy industry moving onto roads that were not designed for this type of activity . I would think you would not expose our rural communities to this very large risk . Protect us and all visitors that we love very much .

Sharon Bishop - Sharon Bishop

Norwich Township

6325 Scottwood Rd

Willard, Ohio

17-2295-EL-BGN

We also visited the Van Wert area + talked to people. Most of them were not happy. One man said they are going to put more on my property. I said go ahead you have all ready Ruined my farm.

Shirley Wagner
4197E TR 44
Sycamore Oh

Eden Twp
Seneca Co

9/12/19

In opposition to the Republic Wind Project/ Apex

OPSB# 17-2295-EL-BGN

Terri Hampshire

Bloom Township/ Seneca County Ohio

I want to thank you first and foremost for listening to the concerns of the many people that will be affected by these massive wind projects that could change our lives forever in a very negative way.

I am a lifelong resident of Seneca County and for a very good reason. I was born and raised here. I have raised my 2 children on the property I have called home for 30 years. I love my existence here. It's peaceful and beautiful. I thank God on my evening walks for allowing me to live in such a wonderfully serene, rural residential, area. I feel completely blessed. A year and a half ago I was stunned to find that that very existence could change forever without the residents having a say one way or the other.

One of my biggest concerns for my family and neighbors would be our right to medical air ambulance/ lifeflight. We are rural America. We are serviced by a volunteer fire and rescue department which means when an emergency is called in the EMT's have to first meet at the station, make their way to the emergency, assess the situation, call for air ambulance and then potentially move the person to the ambulance and transport them to a "safe place" for lifeflight to land. These could potentially be life and death minutes. REALLY? Why should our lives be subject to this kind of danger, danger of death, so a few lease holders and big wind companies can pad their pockets? The idea of this should make anyone sick!

Our lives are important too yet my family has to endure all of the ill effects and disadvantages of these ugly, bird killing, ice throwing, light blinking, noise making 600+ ft. Industrial wind turbines. Leaseholders say it's their right to do what they want with their land...Once again what about my property rights? When your shadow flicker crosses my property line and comes into my home and effects my way of life? Well that seems extremely one sided with the lease holders to me...

I personally find the thought of living under these huge moving iron structures frightening! I have seen pictures and they are massive!! This is why we are fighting so hard, to keep our peaceful existence intact. Thank you for your time,

Terri Hampshire

17-2295-EL-BGN

My name is Jim Dillingham, a retired United States Army Noncommissioned Officer with 22 years of honorable service to our Nation. I have a Veterans Affairs determined disability rating of 70% and am now faced with a life altering decision to relocate my family, all based on my medical condition, should the Seneca, Republic, or Honey Creek wind turbine projects move forward. One of the major disabilities I live with, determined by the VA, is "chronic vertigo". This life altering condition occurred in July of 2000 and I continue to suffer from this disability to this day.

I offer these facts and ask that you consider not only my situation, but those of all non-participating residents affected by these projects and how it will affect our health, welfare, and daily living environment. Through my own research on medical issues associated with wind turbines, I've been in direct contact with Dr. Jerry Punch, an audiologist and Professor Emeritus at Michigan State to gain his professional opinion on the issue (a copy of his letter written on my behalf is included). The topics I face with my condition include, but are not limited to, shadow-flicker and infrasound.

I urge you to consider all information discussed within Dr. Punch's letter, coupled with the World Health Organization's report on Environmental Noise, as constructing turbines in such close proximity of residential homes will only lead to adverse living and health conditions for us residents.

Thank you.

MICHIGAN STATE
UNIVERSITY

January 15, 2019

To Whom It May Concern:

At the request of Mr. James Dillingham of Scipio Township, I write this letter to express concern for his health as it relates to sPower's proposed Seneca Wind Project. The emphasis of my concern is the low-frequency noise and infrasound emitted by industrial wind turbines, which is known to lead to, or exaberate, a variety of adverse health effects. Mr. Dillingham is a U.S. Army veteran who has been diagnosed by the Department of Veterans Affairs with chronic vertigo, among other service-connected disabilities. Vertigo can be either *objective*, in which stationary objects in the environment appear to be in motion or spinning, or *subjective*, in which the individual has a sensation of rotating or spinning. During severe episodes, vertigo is an aggressively debilitating condition during which an individual is in a state of dysfunction and must remain motionless until the episode passes.

As a retired, certified audiologist with 50 years of clinical, research, teaching, and administrative experience in my profession, I am intervening on Mr. Dillingham's behalf because of my understanding of the anatomy and physiology of the human ear, and how sound is produced, propogated, measured, and perceived by humans. I have almost 10 years experience as a consulting expert witness in various legal cases on behalf of citizen intervenors who are concerned with the potential adverse health effects of wind turbine noise. I am not a physician, but given that Mr. Dillingham has already been medically diagnosed with vertigo and other chronic health conditions, he is not requesting that I diagnose his personal health status, but instead is requesting an evaluation of whether exposure to the proposed wind project has the potential to worsen his vertigo and possibly cause additional health issues. This type of evaluation is known as *causation assessment*, as opposed to *differential diagnosis*.

The World Health Organization states that individuals who are most vulnerable to the detrimental effects of environmental noise are the very young, the elderly, and those with chronic health conditions. Certainly, Mr. Dillingham falls into the latter category, and his concerns deserve special consideration. The WHO has established guidelines for limiting community and environmental low-frequency noise in documents published in 1999[1] and 2009.[2] In the 2009 guidelines, the WHO recommended that average, A-weighted noise levels outside a residence, designated as *LAeq,outside*, not exceed 40 dB to avoid substantial annoyance, sleep disturbance, and other adverse health effects. It established limits specifically for wind turbine noise for the first time in its most recent guidelines,[3] recommending that noise emissions from turbines not exceed 45 dB Lden. The Lden metric penalizes evening and nighttime noise levels by 5 and 10 dB, respectively, relative to daytime levels, and a level of 45 dB Lden is equivalent to an Leq of 38.3 dB. Levels

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between 38-40 dB Leq are in agreement with those recommended by Dr. Paul Schomer, a prominent acoustician who is the former Director of the Standards Division of the Acoustical Society of America.

It is important to understand that all of these metrics for reporting decibel levels are based on A-weighting, which is used for its convenience in expressing noise levels across a range of frequencies as a single number. A-weighting, however, effectively excludes infrasound and substantial amounts of low-frequency noise and is regarded by most independent acousticians as inadequate either to predict the level of outdoor or indoor infrasound or to reveal a definitive relationship with adverse health impacts. The effects of infrasound are best assessed by using narrow-band frequency analysis at frequencies below 20 Hz or by comparing A-weighted levels to C-weighted levels, the latter of which encompass more low-frequency information. The 1999 WHO community noise guidelines discuss in detail the fact that averaged levels do not adequately account for any momentary peaks of low-frequency noise and infrasound (such as those emitted by wind turbines). The amplitude modulation in wind turbine noise is believed to lead to extreme annoyance, sleep disturbance, negative sensations, and adverse health effects.

In 2016, I co-authored with acoustician Richard James an article titled *Wind turbine noise and human health: A four-decade history of evidence that wind turbines pose risks.*[4] In it, we reviewed the scientific literature that largely disputes many of the major postions taken by the wind industry with regard to the causative relationship between wind turbine noise and adverse health effects. Because of that article's length—55 pages of text and 17 pages of references—most people are likely to skim through it or ignore it completely, so I would like to summarize below our major conclusions, with special emphasis on those aspects that relate to Mr. Dillingham's health concerns.

While audible noise from wind turbines is known to disturb sleep, be extremely annoying, and substantially reduce quality of life, health symptoms such as headaches, dizziness, nausea, and motion sickness seem to be explained best by exposure to infrasound. Paller et al.,[5] in Canada, found a statistically significant association between wind turbine noise and vertigo, although few studies have established a direct causative relationship. Schomer and colleagues[6] have explained that the types of vestibular symptoms reported by individuals living near wind turbines, including vertigo, are similar to motion sickness, which is known to be induced by very low-frequency sources below 1 Hz—which modern wind turbines are known to produce. Their study indicates that the vestibular components of the inner ear appear to be central to motion sickness and other balance disorders reported by persons living near wind turbines. Dr. Nina Pierpont[7] has explicitly described the relationship between complaints associated with wind turbine noise exposure and migraines, motion sickness, vertigo, gastrointestinal sensitivity to noise and visual stimulation, and anxiety. Despite the wind industry's vigorous denials, recent research is largely consistent with Dr. Nina Pierpont's original description of symptoms resulting from exposure to wind turbines, which she termed *Wind Turbine Syndrome.*

Wind turbine noise has unique acoustic characteristics when compared to other environmental noises. Those characteristics include amplitude modulation with intermittent occurrences of tones that mirror the peak energy of the blade-pass frequency and the first several harmonics. Infrasound emissions from wind turbines can also resonate air inside closed rooms, effectively amplifying any acoustic energy that is present, and can resonate, or vibrate, organs and tissues of the human body.[8] The wind industry often states that infrasound from turbines is less intense than infrasound generated by other environmental sources or within the human body itself. Based on its anatomical characteristics, however, the inner ear is capable of preventing internally generated sound, but not externally generated sound, from being perceived, which means that perception of wind turbine infrasound may be far more disturbing than any infrasound generated within the body. Also, infrasound is more perceptible when higher frequencies are absent, meaning that conditions are likely to be at their worst in a quiet bedroom at night, when higher frequencies are relatively attenuated by the surrounding structures of a residence.

Advocates of wind energy also take the position that levels of infrasound and low-frequency noise generated by modern wind projects are well below those that adversely affect health, and that there is no accepted physiological mechanism that explains how sub-audible infrasound can affect health. Wind advocates superficially reject the work of Dr. Alec Salt and colleagues, who have explained in detail the physiological mechanisms by which the cochlear and vestibular mechanisms of the inner ear process infrasound and how infrasound stimulates various regions of the brain to result in unpleasant sensations. Dr. Salt is a highly reputable scientist who is known as a preeminent investigator of the inner ear, and is a recipient of numerous grants from the National Institutes of Health. In laboratory studies of lower animals that have similar ears to humans, Salt and his colleagues have shown that low-frequency tones presented at moderate to moderately intense levels for no more than three minutes can induce endolymphatic hydrops, commonly known as Menière's disease, in which vertigo is a major symptom.

Noise reports conducted by wind industry acousticians frequently indicate that no scientifically valid studies have shown a causative or direct relationship between modeled or measured levels of wind turbine noise and adverse health effects. Such a conclusion reflects an overly narrow and self-serving understanding of causation, and ignores the role of mediators between noise and health, which include annoyance, stress, anxiety, and sleep disturbance. The Bradford Hill criteria[9] consist of rules by which evidence of causative relationships between diseases and environmental exposures should be established. Those rules include the notion that while epidemiologic research is helpful in that regard, evidence from other sources must also be considered. In addition to numerous anecdotal reports, researchers have provided a large body of scientific evidence in peer-reviewed journals, government documents, print and web-based media, and in scientific papers presented at professional meetings that indicates a general causal link between a variety of adverse health effects and noise emitted by industrial wind turbines. For detailed information regarding that evidence, readers can refer to the review article by Punch and James.[4]

In my professional opinion, Mr. Dillingham can be expected to experience worsened health symptoms if forced to live in close proximity to one or more wind turbines. If the proposed Seneca Wind Project is approved, I would urge that the approval process take extraordinary precautions to avoid exposing him to potentially devastating consequences to his health. The same concern should be applied to any other residents within the vicinity of the project who exhibit similar health conditions.

Respectfully submitted,

Jerry Punch, Ph.D.
Professor Emeritus

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17-2295-EL-BGN

Stop Emerson Creek Wind Farm 18-1607-EL-BGN & Republic Wind LLC 17-2295-EL-BGN

I am a resident and property owner for over twenty years in Sherman twp. /Huron co. Ohio my husband and I have worked our entire life (62 & 60 years) to be able to buy our dream home in the peaceful and beautiful country, with all the openness of the landscape. We have always lived in the country because we do not enjoy looking at big, tall man-made structures all around us that city life offers. The gigantic 650 foot turbines they want to build make any structures in the city or anywhere for that matter, look minuscule in comparison. With the proposed wind project all that is threatened, I do not believe the rights of all the residents should be infringed on so a few can make a profit by destroying the peacefulness of the countryside! This is only the first of many concerns with the proposed project.

Infra-sound is a very big concern! While the big wind company's tell us it is perfectly safe, there is too much evidence to the contrary that can be found on the internet. Studies done by very reputable scientist in Germany and Holland have indeed found that it can be very harmful to the human body and animals as well. It has been determined that the sound waves below 20 Hz (which is what wind turbines. Jet engines and locomotives produce) cause thickening of the heart muscle, lung, and kidneys tissue inhibiting their ability to function properly. Infra sound has also been found to cause many other problems, such as, sleep deprivation, headaches, irritability, vertigo and many more. It has also been found to increase birth defects in animals located too close to wind turbines. The us Army and the US Navy became concerned about the soldiers working around jet engines and conducted studies of their own and came up with the same conclusion, that it is indeed harmful to people! Even though we humans cannot hear below this wavelength of 20 Hz it is a very real threat to our health and wellbeing. We cannot see infrared rays either but we understand the dangers of that very well.

Another concern is for our local Bald Eagle nest. This nest is located less than 1 mile of the closest proposed wind turbine and there will be a line of turbines positioned so the eagles will have to fly through them to get to the reservoir where they commonly fish. This nest has been productive for the twenty years that we have lived here and I am not sure how long beforehand. Determining Whether Large Construction or Expansion Activities May Disturb Nesting Bald Eagles:
To avoid disturbing nesting bald eagles and their young it is recommend that you:
Maintain a buffer of at least 330 feet (100 meters) between your activities and the nest (including active and alternate nests), or if a similar activity is closer than 330 feet, then maintain a buffer at least as far from the nest as the existing tolerated activity,

Within 660 (200 meters) feet of the nest, restrict any clearing, external construction or landscaping activities to outside the nesting season (i.e., outside the nesting season is from August through January. The nesting season in the Northeast is generally from mid-December to June. Maintain established landscape buffers that screen the activity from the nest.

Our bat population will also be affected, killing many of a protected species and a most important insect eradicator. They save farmers millions of dollars in insecticide. Studies have shown that bats do not even have to be hit by the blades. All they have to do is get too close to the low pressure area created by the spinning blades and it ruptures the blood vessels causing the bat to die. Big wind is very careful to mention that they do studies to place turbine out of bird migration paths and I am thankful for that, but they never mention the fact that they are still are one of the biggest if not the biggest killers of bats. My question is; how can we allow them to keep building these structures that is already known to kill so many bats-a PROTECTED SPECIES? If I or another individual were to kill one bat the law would be all over us wanting to fine us hundreds of dollars, but they should be allowed to build these turbines already knowing that it will destroy hundreds of bats? I for one do not think they should.

Declining property values is also an important concern. Studies have been done in the Paulding and Wan Wert area where there is already a wind farm, and they have determined that property value has decreased by 25% to as much as 40%! Of course big wind tells that they are not affected at all, another LIE. I have never heard or read anyone say they just dream of saving their money, so they can move out to the country and build a house under these 650 foot giants with giant blades spinning all around them. It is ridiculous to even entertain such a notion! It would be like living in the middle of an industrial park. But yet that is exactly what they want us to do so they can turn a profit. I do not think that our rights to a quiet and peaceful life in the country should be infringed upon so just a few can profit. With declining property values and less property tax being paid because of it. How is this supposed to be a benefit to the schools? It seems that the taxes they promise to pay the schools would just be a trade off from the loss of property tax that they have created.

I feel that our beautiful sky lines need to be saved. With fewer and fewer wild and open places to live in and be enjoyed, I do not feel that our few remaining places in northern Ohio should be desecrated for the purpose of erecting these unsightly giants, where insufficient wind exists anyway. I would much rather hand down a beautiful open countryside to my children and grandchildren than a spraying ugly wind turbine Industrial PARK (not wind FARM as they like to use.) Included in the next paragraph is an excerpt from a study of land use for producing electricity. Wind turbines are shown to be the least efficient of all, as well as, destroying the natural beauty of the land for mile and miles and miles.

The Nature Conservancy published a paper titled "Energy Sprawl or Energy Efficiency: Climate Policy Impacts on Natural Habitat for the United States of America." The report determined that nuclear energy is the least land-intensive, as it requires only 1 square mile to produce 1 million megawatt-hours per year, enough electricity for about 90,000 homes. To produce the same amount of energy, the report determined that geothermal energy requires 3 square miles, coal requires 4 square miles, natural gas needs 8, petroleum needs 18 and bio-fuels (corn and others plants) require up to 500. Wind farms require more than 30 square miles. In sum, green energy will require at least 128,002 square miles of new land to meet current goals by 2030, according to The Nature Conservancy. Let's put this into perspective, we could line 300 miles of mountaintops from Chattanooga, Tenn., to Bristol, Va., with wind turbines and still produce only one-quarter the electricity we get from one reactor on one square mile at the Tennessee Valley Authority's Watts Bar Nuclear Plant.

"Wyoming Gov. Dave Freudenthal sent a letter to the state's senate in which he wrote", Seemingly every acre ... is up for grabs in the interest of "green, carbon-neutral technologies", no matter how "brown" the effects are on the land. It's like taking a shortcut to work through a playground full of school children and claiming "green" as a defense, because you were driving a Toyota Prius. I do not think truer words were ever spoken.

Another concern about wind farms is the Karst geology of Ohio. Karst is a landform that develops on or in limestone, dolomite, or gyp-sum by dissolution and that is characterized by the presence of characteristic features such as sinkholes this also, involves underground mine location points of Ohio, which the extent is unknown. The groundwater flows north through this system of fractures, voids, and partings and emerges (is discharged) at the surface about fourteen (14) miles (23 Kilometers) north of the caverns in the vicinity of the village of Castalia. The presence of artesian springs, seeps, free flowing wells and wetlands characterize this area. The famous Blue Hole at Castalia is but one of many springs in this discharge zone. Water alone can dissolve salt and gypsum but limestone, dolomite and marble are much less soluble and require acidic water to initiate this natural process. Carbonic acid is a mild naturally occurring acid that is present in groundwater. This acid is created when water falling through the atmosphere absorbs small amounts of the carbon dioxide present there. As this slightly acidic rainwater percolates through the soil it absorbs additional carbon dioxide and becomes more acidic. This more highly concentrated weak acidic solution (carbonic acid) readily dissolves calcite which is the principle mineral in limestone and marble and an important mineral in dolomite. I have attached a map of the Karst formation of Ohio.

I implore you to say no to the wind turbines and preserve our quality of life and our pristine countryside!!

Sincerely,

Bob & Ruby C. Klotz
1017 Dogtown Rd
Monroeville, OH 44847

OHIO KARST AREAS

Karst is a landform that develops on or in limestone, dolomite, or gypsum by dissolution and that is characterized by the presence of characteristic features such as sinkholes, underground (or internal) drainage through solution-enlarged fractures (joints), and caves. While karst landforms and features are commonly striking in appearance and host to some of Ohio's rarest fauna, they also can be a significant geologic hazard. Sudden collapse of an underground cavern or opening of a sinkhole can cause surface subsidence that can severely damage or destroy any overlying structure such as a building, bridge, or highway. Improperly backfilled sinkholes are prone to both gradual and sudden subsidence, and similarly threaten overlying structures. Sewage, animal wastes, and agricultural, industrial, and ice-control chemicals entering sinkholes as surface drainage are conducted directly and quickly into the ground-water system, thereby posing a severe threat to potable water supplies. Because of such risks, many of the nation's state geological surveys, and the U.S. Geological Survey, are actively mapping and characterizing the nation's karst regions.

The five most significant Ohio karst regions are described below.

BELLEVUE-CASTALIA KARST PLAIN

The Bellevue-Castalia Karst Plain occupies portions of northeastern Seneca County, northwestern Huron County, southeastern Sandusky County, and western Erie County. Adjacent karst terrain in portions of Ottawa County, including the Marblehead Peninsula, Catawba Island, and the Bass Islands, is related in geologic origin to the Bellevue-Castalia Karst Plain. The area is underlain by up to 175 feet of Devonian carbonates (Delaware Limestone, Columbus Limestone, Lucas Dolomite, and Amherstburg Dolomite) overlying Silurian dolomite, anhydrite, and gypsum of the Bass Islands Dolomite and Salina Group.

The Bellevue-Castalia Karst Plain is believed to contain more sinkholes than any of Ohio's other karst regions. Huge, irregularly shaped, closed depressions up to 270 acres in size and commonly enclosing smaller, circular-closed depressions 5 to 80 feet in diameter pockmark the land between the village of Flat Rock in northeastern Seneca County and Castalia in western Erie County. Surface drainage on the plain is very limited, and many of the streams which are present disappear into sinkholes called swallow holes.

Karst in the Bellevue-Castalia and Lake Erie islands region is due to collapse of overlying carbonate rocks into voids created by the dissolution and removal of underlying gypsum beds. According to Verber and Stansbery (1953, Ohio Journal of Science), ground water is introduced into Salina Group anhydrite ($CaSO_4$) through pores and fractures in the overlying carbonates. The anhydrite chemically reacts with the water to form gypsum ($CaSO_4 \cdot 2H_2O$), undergoing a 33 to 62 percent increase in volume in the process. This swelling lifts overlying strata, thereby opening fractures and creating massive passageways for conduction of greater volumes of ground water through the Silurian Bass Islands Dolomite and into underlying Salina Group strata. Gypsum, being readily soluble in water, is dissolved, creating huge voids. Overlying carbonates then collapse or break down, leaving surface depressions similar to those resulting from roof failure of an underground mine.

DISSECTED NIAGARA ESCARPMENT

The dissected Niagara Escarpment of southwestern Ohio includes the largest single area of karst terrain in the state and the greatest number of surveyed caves. It also is estimated to include the second-largest number of sinkholes in the state. The area is underlain by Silurian rocks of the Peebles Dolomite, Lilley Formation, Bisher Formation, Estill Shale, and Noland Formation in Adams, Highland, and Clinton Counties and the Cedarville Dolomite, Springfield Dolomite, Euphemia Dolomite, Massie Shale, Laurel Dolomite, Osgood Shale, and Dayton Formation in Greene, Clark, Miami, Montgomery, and Preble Counties. The Peebles-Lilley-Bisher sequence and the Cedarville-Springfield-Euphemia sequence constitute the Lockport Group.

Most karst features along the Niagara Escarpment in southwestern Ohio are developed in Lockport Group strata. More than 100 sinkholes and caves developed in the Lockport have been documented in the field, and more than 1,000 probable sinkholes in the Lockport have been identified on aerial photographs, soils maps, and topographic maps. As with most karst terrain, sinkholes developed on the Niagara Escarpment commonly show linear orientations aligned with prevailing joint trends in the area. The greatest concentration of sinkholes on the escarpment is south of the Wisconsinan glacial border in southern Highland and Adams Counties, where highly dissected ridges capped by Silurian carbonate rocks rise 150 to 200 feet above surrounding drainage. Illinoian till in these areas is thin to absent, and soils are completely leached with respect to calcium and calcium-magnesium carbonate. Such geologic settings are ideal for active karst processes, as downward-percolating, naturally acidic rain water is not buffered until it has dissolved some of the underlying carbonate bedrock. Other significant karst features of the Niagara Escarpment include small caves in escarpment re-entrants created by the valleys of the Great Miami and Stillwater Rivers in Miami County.

BELLEFONTAINE OUTLIER

The Bellefontaine Outlier in Logan and northern Champaign Counties is an erosionally resistant "island" of Devonian carbonates capped by Ohio Shale and surrounded by a "sea" of Silurian strata. Though completely glaciated, the outlier was such an impediment to Ice Age glaciers that it repeatedly separated advancing ice sheets into two glacial lobes—the Miami Lobe on the west and the Scioto Lobe on the east. Most Ohioans recognize the outlier as the location of Campbell Hill—the highest point in the state at an elevation of 1,549 feet above mean sea level.

Although it is not known for having an especially well-developed karst terrain, the outlier is the location of Ohio's largest known cave, Ohio Caverns. The greatest sinkhole concentrations are present in McArthur and Rushcreek Townships of Logan County, where the density of sinkholes in some areas approaches 30 per square mile. Sinkholes here typically occur in upland areas of Devonian Lucas Dolomite or Columbus Limestone that are 30 to 50 feet or more above surrounding drainage and are covered by less than 20 feet of glacial drift and/or Ohio Shale.

SCIOTO AND OLENTANGY RIVER GORGES

The uplands adjacent to the gorges of the Scioto and Olentangy Rivers in northern Franklin and southern Delaware Counties include areas of well-developed, active karst terrain. These uplands also are among the most rapidly developing areas of the state, which means karst should be a consideration in site assessments for commercial and residential construction projects.

The Scioto River in this area has been incised to a depth of 50 to 100 feet into underlying bedrock, creating a shallow gorge. The floor, walls, and adjacent uplands of the gorge consist of Devonian Delaware and Columbus Limestones mantled by up to 20 feet of Wisconsinan till. Sinkhole concentrations up to 1 sinkhole per acre are not uncommon in Concord, Scioto, and Radnor Townships of Delaware County. The sinkholes range in diameter from about 10 to 100 feet and commonly are aligned linearly along major joint systems.

The Olentangy River is approximately 5 miles east of the Scioto River in southern Delaware County and occupies a gorge that is narrower and up to 50 feet deeper than the Scioto River gorge. The floor and the lower half of the walls along the Olentangy gorge are composed of Delaware and Columbus Limestones, the upper half of the walls is composed of Devonian Ohio and Olentangy Shales mantled by a thin veneer of glacial drift. Karst terrain has developed along portions of the gorge in a manner similar to karst terrain along the Scioto River.

ORDOVICIAN UPLANDS

The Ordovician uplands of southwestern Ohio are the location of surprisingly well-developed karst terrain despite the large component of shale in local bedrock. Numerous sinkholes are present in Ordovician rocks of Adams, Brown, Clermont, and Hamilton Counties.

The carbonate-rich members of the Grant Lake Formation (Bellevue and Mount Auburn), Grant Lake Limestone (Bellevue and Straight Creek), and the upper portion of the Arnheim formation are the Ordovician units most prone to karstification; however, the shale-rich (70 percent shale, 30 percent limestone) Waynesville Formation also has been subjected to a surprising amount of karst development in southeastern Brown and southwestern Adams Counties, just north of the Ohio River.

ACKNOWLEDGMENT

The Division of Geological Survey gratefully acknowledges the Ohio Low-Level Radioactive-Waste Facility Development Authority for its financial support for mapping Ohio karst terrain.

OHIO KARST AREAS

The Northeast portion of Seneca County is part of the Bellevue-Castalia Karst Plain. "It is believed to contain more sinkholes than any of Ohio's other karst regions." "While karst landforms and features are commonly striking in appearance and host to some of Ohio's rarest fauna, they also can be a significant geologic hazard. Sudden collapse of an underground cavern or opening of a sinkhole can cause surface subsidence that can severely damage or destroy any overlying structures." CLICK LINK HERE

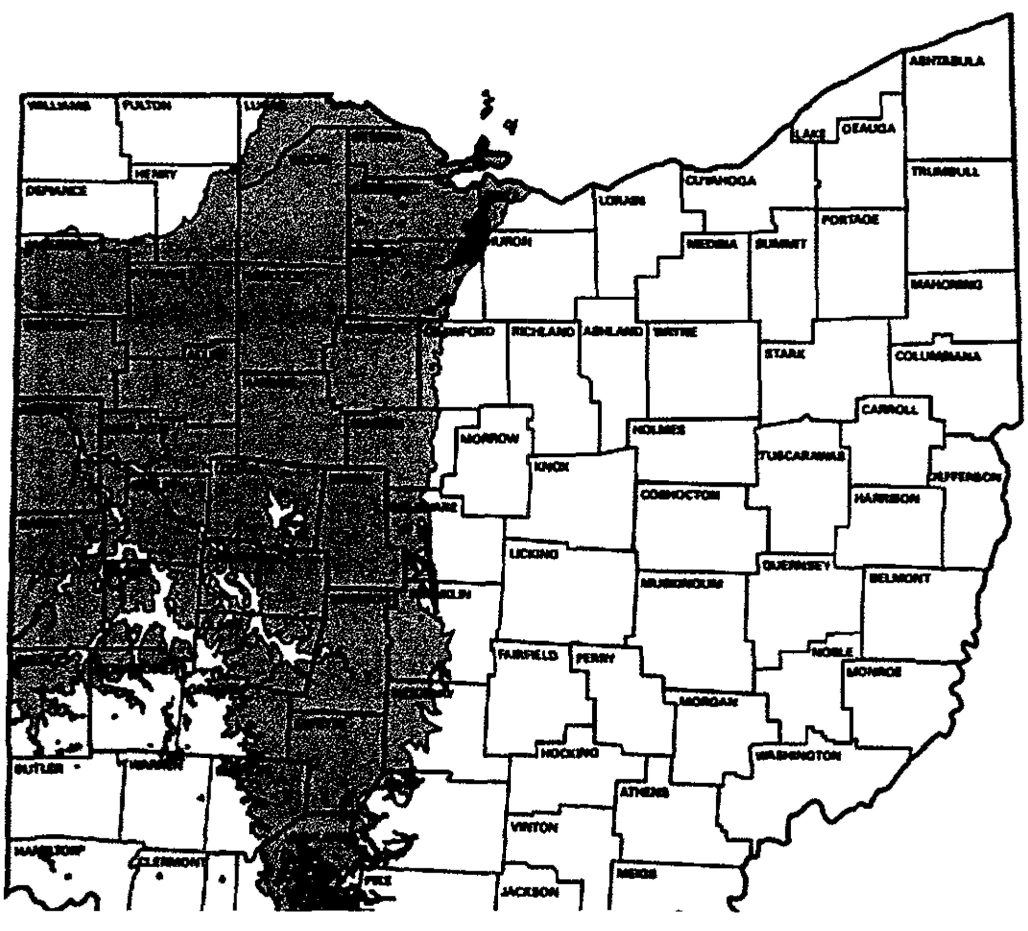
The Bellevue-Castalia Karst Plain is believed to contain more sinkholes than any of Ohio's other karst regions. Huge, irregularly shaped, closed depressions up to 270 acres in size and commonly enclosing smaller, circular-closed depressions 5 to 80 feet in diameter pockmark the land between the village of Flat Rock in northeastern Seneca County and Castalia in western Erie County. Surface drainage on the plain is very limited, and many of the streams which are present disappear into sinkholes called swallow holes.

STATE OF OHIO
Bob Taft, Governor

DEPARTMENT OF NATURAL RESOURCES
Samuel W. Speck, Director

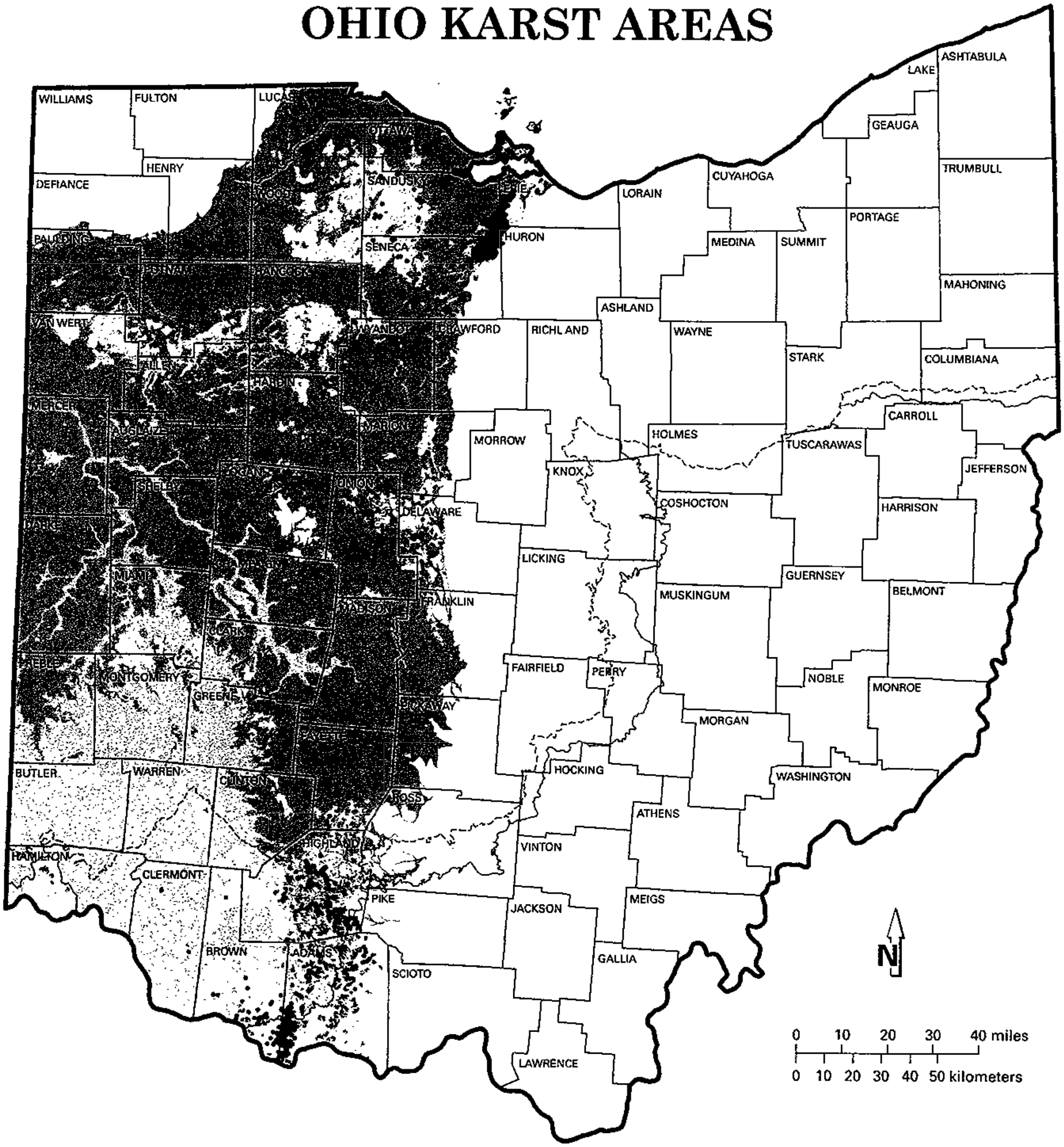
DIVISION OF GEOLOGICAL SURVEY
Thomas M. Berg, Chief

OHIO KARST AREAS



STATE OF OHIO • DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

OHIO KARST AREAS



EXPLANATION

Silurian- and Devonian-age carbonate bedrock overlain by less than 20 feet of glacial drift and/or alluvium

Silurian- and Devonian-age carbonate bedrock overlain by more than 20 feet of glacial drift and/or alluvium

Interbedded Ordovician-age limestone and shale overlain by less than 20 feet of glacial drift and/or alluvium

Interbedded Ordovician-age limestone and shale overlain by more than 20 feet of glacial drift and/or alluvium

Probable karst areas

Area not known to contain karst features

Wisconsinan Glacial Margin

Illinoian Glacial Margin

Recommended citation: Ohio Division of Geological Survey, 1999 (rev. 2002, 2006), Known and probable karst in Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map EG-1, generalized page-size version with text, 2 p., scale 1:2,000,000.

17-2295-EL-BGN

Steve and Linda Mullogan 9/12/19
10216 E. CR 24
Republic 44867
Republic Wind: OPSB

As land owners we are very concerned of the effect on our wells from the seismic movement of these industrial wind turbines. We have no other source for human and animal use.

We have many barn swallows, some bats, hawks and bald eagles ranging around our 40 acre farm. They will definitely be impacted by these turbines.

Life flight has used our property for accidents in our area.
Crop planes also used in our area.

When I walk my property the fear of blade throws and ice.

This project is too close to our school and a well populated area.

When trains are parked,
Railcars with placards of
Combustible & flammable liquids,
How close is the nearest turbine?

The efficiency of these turbines!
Asbestos in the air from breaks
Fires from these units/woods & fields.

Disposal of these blades
Estimated 720,000 tons of blade
material to dispose of in the
next 20 years. Not including the
larger units. Wow!!
Ref: Harvest Public Media
Ref: Christina Stella.

Please give our concerns your
attention.

Thank You. Land owner of Beautiful Ohio!!
Linda + Steve

17-2295-EL-BGN

Testimony of Kurt Lease

5251 E. County Rd. 16

Tiffin, OH 44883

Ohio Power Siting Board

Republic Wind Public Hearing September 12, 2019

Case # 17-2295-EL-BGN

Members of the Board,

My name is Kurt Lease. I object to this project because of the unsafe conditions that will result from building these turbines, and because of the lack of input allowed by the local citizens.

One of the safety issues is the impact the turbines will have on air ambulances. I have been a member of the Bloom Township volunteer fire department for 21 years. Our department has responded to many accidents where air ambulances have had to land on scene to evacuate the wounded. This is often under less than ideal weather and visibility conditions. Turbines will most certainly prevent some on scene landings. I can tell you from experience that these accidents can be gruesome. I have personally called for an air ambulance at an auto accident and was later told that the victim would not have survived had the air ambulance had been delayed. Being able to land a helicopter on scene is many times the only thing that can save lives.

At the very least someone is going to have to build and maintain several helicopter landing pads in select areas throughout the project that patients can be moved to with a ground ambulance. Shouldn't the wind company have to pay for that instead of taxpayers? But even then, the extra time and extra moving of trauma victims will cost lives over time.

Another safety issue is injury by the turbines themselves. The old saying of "Good fences make good neighbors" is a good way to look at this subject. It is now public knowledge that large wind turbines can and do have blade failures. 3800 per year is the number often quoted. The blade throw workshop held by the Power Siting Board earlier this year was a real eye opener for everyone. Now we know that pieces of blade, large enough to cause severe injury, fly hundreds of feet farther than the current setbacks used in the design of this project. With that type of information shouldn't the board be considering longer setbacks than the minimums the Ohio Revised Code currently define? How can this project be given the go ahead knowing it is putting public safety at risk? Why is there no mention of this known blade throw safety hazard in the staff report?

Today's "public hearing" is supposed to be the time when the board receives input from the public. We would hope that you might consider what we have to say, especially our concerns about public safety. But the staff released its report 3 weeks ago. How can you say our input means anything to you at all? This entire process makes no sense. You make your decisions with no input from the people who will have to live inside the projects for several decades, and you don't even consider our safety. How can you expect us to do anything other than oppose the plan? It should be no surprise to see us trying as hard as we can to defend our homes and families. You know the turbines are dangerous at the distances drawn on the plans. Please make public safety the number one priority on your list by moving them to a safe distance. Make sure something is done to help the air ambulance issue. I have personally volunteered my time to help protect our citizens and wouldn't think twice about doing again if asked. Now it's your turn to do the same. You have no higher duty than to protect the people of Seneca County and Ohio.

Thank you.

Kurt Lease

OPSB # 17-2295-EL-BGN

On August 28, 2017, Rhonda Zerman, her mother, Patricia and I spoke with Apex employees at their Bellevue office to discuss our situation. Apex had informed us that the lease held by Patricia Heuring Zerman for 1 turbine on land surrounding our building lot was to expire in 2018, so they wanted Patricia to re-sign. We verified with these employees that Patricia would not be re-signing and wanted out of her contract. Sometime later, I was told that the contract would expire November 30, 2018. But on November 29, 2018, Patricia received a "Project Commencement Notice", extending the Apex lease.

We only decided to build our home there, knowing the contract for the turbine would expire November 2018! Needless to say, we were devastated to learn, as part of the Republic Wind project, Apex intents to erect a 602' turbine, directly behind our new home. At this point, we were well into the process of building on our 1.7 (non-participating) acres.

All of us need your help!

We need you to listen to the warnings from the people already effected by Infrasound, shadow flicker, vibration, lights, etc., causing sleep disruption, headaches, vertigo, nausea and the ever- growing list of other health issues. Unlike traffic, planes, and other sources of intermittent noise, the turbine noise level is continuous. The current setbacks are certainly insufficient for the infrasound generated by 602 foot wind turbines!

We need you to hear the negative effects on wildlife. With the growing number of deaths from the West Nile virus, why would we want wind turbines killing large numbers of bats, which could help protect us by keeping the mosquito population down? Or with this area being a global migration area, they could cause devastating bird kills. (The Apex bird studies were done outside of the migration time.)

We need you to hear about the failure rates of these turbines, which wind companies ignore. An average of 3,800 blade failures each year! Who will be available when repairs are needed? To what company will Apex have sold this and their other projects as soon as they are established? Who will be available to put out the fires caused by these failed monstrosities? Due to the height of these turbines, the fires must be allowed to burn themselves out. But there must also be concern when this burning debris falls to the ground, especially near wooded areas and dry farm fields!

We need you to consider, if tragedy should strike in this area, how will emergency medical transport reach individuals forced to live too near the turbines? There must be consideration given not only to the interrupted radio transmissions of *law enforcement, medical transport and weather reporting, but to the altered flight patterns of life flight. There will be* times that emergency air transportation will not be able to fly in areas where they are needed! Life flights cannot land within 1.5 miles of a turbine, which will severely impact their response times for emergencies.

Will peoples' lives be lost to "Big Wind's Experiments"?

We need you to consider the fact that of the 50 proposed wind turbines in the Republic Wind project, 27 are located on karst features. What options are available to these rural families when our wells are contaminated?

Not only is this project destroying property values and the equity in owner's homes, they have no regard for the potential safety and/or health issues of the families who will be forced to live within unsafe distances of these turbines. There are also risks of blade throws that could be up to 5,000 feet, far surpassing the current setback laws!

The wind companies should not be allowed to have such disregard for human health and safety!

All property owners should be allowed a voice in these decisions! Please consider the views of those property owners who want to live a peaceful "country life" without endangering their family's health and safety.

Please consider the safety of human lives in your all of your decisions.

Thank you for your time,

Jeff Gates and Rhonda Zerman
Owner of property located on Twp Rd 138, Republic OH

September 5, 2019

Jeff Gates Rhonda Zerman

912/2019

CASE 17-2295-EL-BGN

Republic Wind

Tom and Shelley Smith

11376 E. TR 8

Republic, Oh 44867

To: Ohio Power Siting Board

As residents of Reed Township in Seneca County we are against the Republic Wind Project. We have health and safety concerns due to infrasound, EMF, blade throw, shadow flicker and the fragile karst in this area. There are also concerns of Life Flight being able to access our area if these 600 ft. turbines are built. This project will change our landscape forever; we are a rural community not an industrial park. Had we known this could be in our future we would have never chosen to live in this area. If our family has health, safety or money issues due to this project, who will be responsible - Apex, leaseholders the powers who allowed it? Shouldn't we all have a voice in something that so heavily can affect our family's future? We ask that you deny the Republic Wind Project.

Thank You for your time,

Tom and Shelley Smith

912/2019

CASE 17-2295-EL-BGN

Republic Wind

Bryan Stacklin

210 S. Main St.

Attica, Oh 44807

To: Ohio Power Siting Board

As a resident of Seneca County I am against the Republic Wind Project. The majority of the residents in the project area are against these projects. We have health and safety concerns due to infrasound, blade throw, shadow flicker and the fragile karst in this area. This project will harm our wildlife, negatively affect our home values and scar our rural landscape. We ask that you deny the Republic Wind Project.

Thank You,

Bryan Stacklin

Carol Burkholder
6641 E. TwpRd 130
Republic, OH 44867
Sept. 12, 2019

RE: CASE No. 17-2295-EL-BGN

I have a collection of 90 letters written to the Editor of THE ADVERTISER TRIBUNE that are in opposition to the construction of wind trubines in Seneca County, Ohio.

These letters were submitted by over 50 people who care deeply about their homes, families and land where they live, Seneca County, Ohio. They contain many concerns about the negitive impact that 600ft tall turbines would have on their lives. The one thing they all have in common is LOVE. Love for their rural surroundings the quiet, peaceful, starry dark nights, things that feed a persons soul.

In a country where drug abuse and mass shootings are running rampent. Maybe it might be prudent to place more value on SAVING the places that are still left where people are able to find peace.

Carol Burkholder
ph: 419-585-4813

Good afternoon, Judge and members of the Ohio Power Siting Board. I am Krista Beck and I reside at 11304 Strecker Rd, Bellevue, Ohio. I have a vested interest in the Republic Wind Project because I am the 6th generation of my family to live in Groton Township, Erie County which is also a part of the Bellevue/Castalia Karst Region.

In-depth studies performed by The ODNR Division of Geological Survey and Division of Water revealed that the Bellevue/Castalia Karst Region has:

- The largest sinkholes in the state by perimeter, volume, area, and axis..
- More than 1,000 verified sinkholes
- Highly developed "sinks" because of the ancient lakes and underlain gypsum evaporates and increased bedrock fracturing from multiple glacial events in the area
- Higher dissolution activity and merging of sinks that create larger sinks than other areas
- Less than 20 feet of glacial drift or none at all which..."**makes this area prime for karst development."**

According to the Ohio Department of Transportation's report on *Standard Operating Procedures for Drinking Water Resources*, the Bellevue/Castalia Karst encompasses 13 public water systems (and thousands of private resident wells) that use the karst area as a drinking water source.

Geological Survey's new online, interactive karst map provides a critical tool to show how massive the Bellevue/Castalia Karst Region is, and how we cannot use arbitrary boundaries such as township, county or wind project lines to separate one area of this karst region from all the other connecting sink holes, aquifers and springs. The karst is an interconnected system from southern Seneca County, through Sandusky, Huron, and Erie Counties, all the way to Sandusky Bay and Lake Erie.

The historic Bellevue flood of March 2008, that lasted for more than 50 days, which was extensively studied and documented, is a prime example of how interconnected the karst underground water systems are. The attached map (Figure 1) was created to illustrate this point and was constructed by overlaying 2 different maps.

1.The first map (blue area) is Figure 6 from the report entitled "Ground Water Induced Flooding in the Bellevue Ohio Area Spring and Summer 2008" written by the Divisions of Water and Geological Survey.

https://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/Karst/Bellevue_Final_Report.pdf

2. The second part of the map is from an interactive turbine map that was created on Google Maps by using the coordinates that Republic Wind provided for the proposed turbine sites. (45 /50 proposed turbines sites are shown due to the scale of the maps)
https://www.google.com/maps/d/u/0/viewer?mid=1tV_4EOL7OXua6CLW93e5IxEISzakGF84&ll=41.20199588354031%2C-82.9125813337223&z=12

The blue area of the map shows what the ODNR's *Final Bellevue Report* determined the ground water contribution zone to be for the 2008 flood event. This area encompasses approximately 57,000 acres.

You can see that ground water from the southern part of the karst region, and more than 10 miles away from Bellevue, contributed to the flood that encompassed the city proper, York Township to the northwest and Groton Township to the north. The most striking aspect is that 32 of the proposed Republic Wind Turbines sit directly in the ground water contribution zone!

It is impossible for us to ignore the risks of erecting dozens of massive Industrial Wind Turbines into our vulnerable, unpredictable, and sometimes destructive karst region. It will affect all of us who live within the karst region.

The geologists that wrote the *Final Bellevue Report* made recommendations that "Local government agencies should consider mandating no permanent structures within the areas that flooded."

Even the Ohio Division of Geological Survey states, "Karst...is a geological hazard that Ohioans must live with. As with any geological hazard, however, the risks to property and health from living on karst can be greatly reduced by *using common sense and maintaining a sense of respect for both the power and vulnerability of the environment."*

Erecting turbines in the most developed karst region in the state makes no sense!

On behalf of all the citizens who live within the Bellevue/Castalia Karst Region, and have experienced firsthand its unpredictability and it's destruction, I ask the Ohio Power Siting Board to deny the Republic Wind Project.

Respectfully,

Krista Beck

Krista Beck

WIND PROJECT
REINEKE
REFERENDUM
We all deserve a voice!
~WIND~
PROJECT

Figure 1. Proposed Republic Wind Turbines in Bellevue Karst

GROUNDWATER INDUCED FLOODING IN THE BELLEVUE OHIO AREA

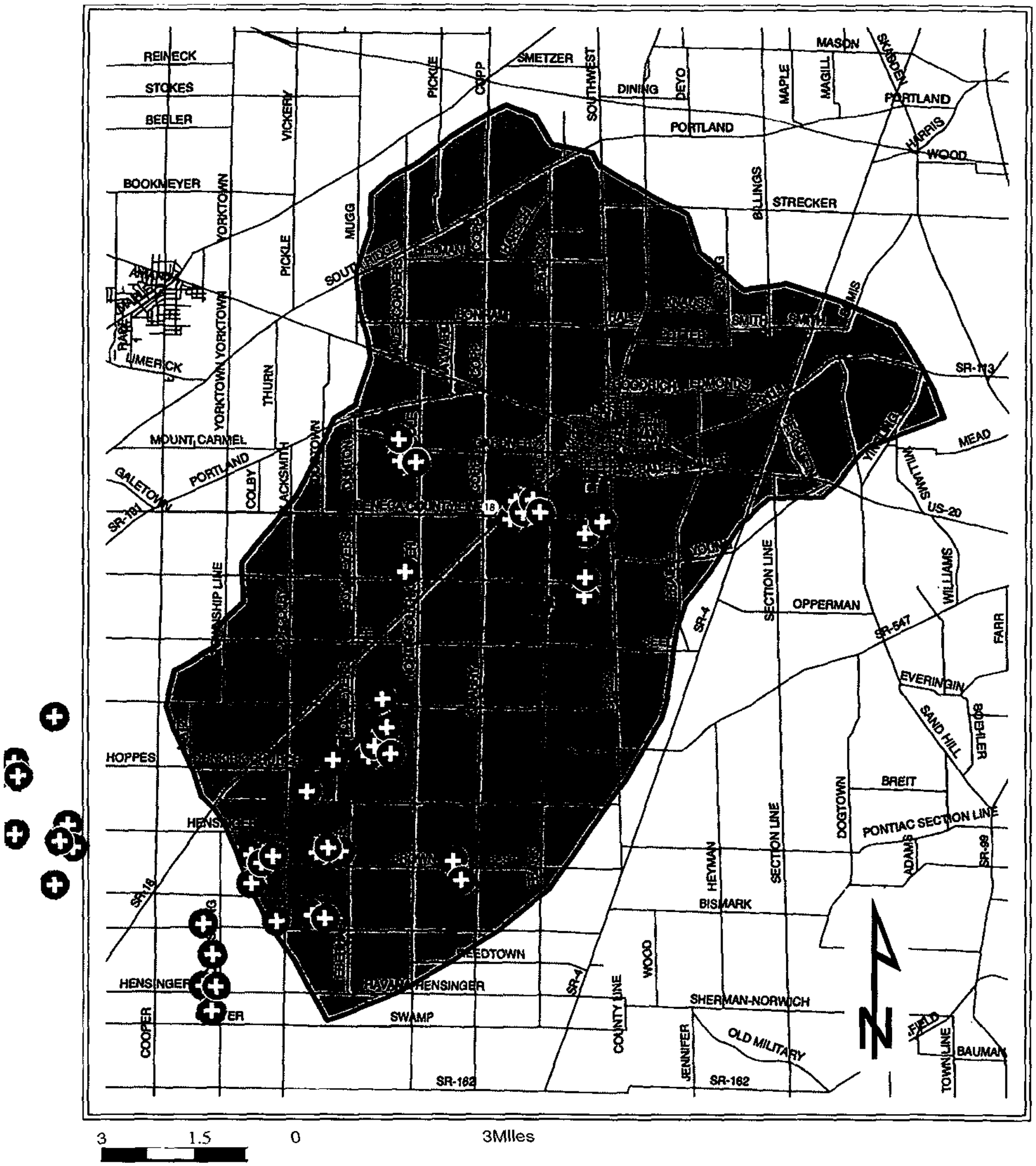


Figure 6.- Ground water contribution zone for the flooded areas.

Used by permission from *Ground Water Induced Flooding in the Bellevue Ohio Area Spring and Summer 2008* https://scholarworks.iu.edu/dspace/bitstream/handle/2022/14044/Bellevue_Final_Report.pdf;sequence=1

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Raab, James et al. January 2009.*Ground Water Induced Flooding in the Bellevue Ohio Area Spring and Summer 2008.* (See Figure 3 as well for karst areas in north central Ohio) *https://scholarworks.iu.edu/dspace/bitstream/handle/2022/14044/Bellevue_Final_Report.pdf;sequence=1*

Republic Wind Farm, Case number: 17-2295-EL-BGN, Ohio Power Citing Board http://dis.puc.state.oh.us/TiffToPDf/A1001001A18L27A92109G03411.pdf)

Swinford, E. Mac. 2018 et al. *Karst Flooding in Bellevue Area and Vicinity-2008.* https://scholarworks.iu.edu/dspace/handle/2022/14621

17-2295-EL-BGN

TIFFIN-SENECA
ECONOMIC PARTNERSHIP

Tiffin-Seneca Economic Partnership
19 W. Market St., Suite C
Tiffin, Ohio 44883

Written Comments Regarding Seneca Wind Project
Republic Wind Public Hearing
Case 17-2295-EL-BGN
September 11, 2019

Ohio Power Siting Board
180 East Broad Street
Columbus, OH 43215

Dear Ohio Power Siting Board:

I hereby submit this letter and the following Statement on the Economic Development Benefits of Wind Projects as written comments in Case 17-2295-EL-BGN, Republic Wind LLC's application to construct a wind farm in Seneca County. Given the length and complexity of this document, written testimony is our choice for providing input in this case. As described by the OPSB, the proposed Republic Wind Farm would be situated on leased private land in Adams, Pleasant, Reed, Scipio, and Thompson townships in Seneca County. The facility would consist of up to 47 wind turbines with a total generating capacity of up to 200 megawatts.

As the organization tasked with leading economic development in rural Seneca County, the Tiffin-Seneca Economic Partnership was asked to provide a statement for the Board of Seneca County Commissioners throughout 2018, and after several months of due diligence, research, and reflection, we produced this thoughtful 87-page document which on January 7, 2019 was submitted to them and which then became a public document. The Seneca Wind project and its economic development benefits are addressed specifically within this document, as are the context, caveats, and limitations of our assertions and conclusions.

In summary, we estimate the Republic Wind project would generate an estimated $1,764,180 annually in tax revenue to be distributed among more than 20 public entities. This would total $52,925,400 over 30 years. It would also create 10 new permanent, full-time operational jobs at an average wage of $28.85 per hour. The investment and tax revenue are substantially higher than the average industrial expansion in Seneca County.

This submission has been provided as part of us fulfilling our dual role as an economic development organization with respect to wind projects, as agreed upon by our Board of Directors and Executive Committee. One, to provide traditional economic development services to all legal business. Two, to serve as a subject matter expert on the economic development benefits of economic development projects. The written comments submitted fall within this second area and are a true statement of the facts as we know them with respect to the benefits of this project. The statement also describes the assumptions and limitations of our analysis.

It is also important to note for the record that the Tiffin-Seneca Economic Partnership has taken a neutral stance with respect to this project and other wind projects, meaning we are not advocating for or against it as being in the public interest. The project and its multiple impacts are complex and multifaceted, and we are neither in a position to speak authoritatively on issues outside of economic development benefits, nor is that our role, as defined by the Board of Trustees.

If you have any questions about our testimony and/or if you think we could be helpful in any way, please do not hesitate to contact me by email at zak@tiffinseneca.org or by cell at 419.912.1150.

Best regards,

David R. Zak
President & CEO

TIFFIN-SENECA
ECONOMIC PARTNERSHIP

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Statement on the Economic Development Benefits of Wind Projects
January 4, 2019

1. Introduction

Throughout 2018, there has been a lot of discussion about the pros and cons of wind power in Seneca County, specifically about the risks, costs, benefits, and value of the two industrial wind turbine developments proposed by both Apex and sPower in Seneca County for 2019. sPower submitted their application to the Ohio Power Siting Board on July 16, 2018. Apex just resubmitted their amended application on December 26, 2018.

At the official request of the Seneca County Commission, the Tiffin-Seneca Economic Partnership (TSEP) has been asked to issue a statement on the economic development benefits of these wind projects. This document serves as that statement, which TSEP reserves the right to revise. It seems an opportune time, as Apex has just resubmitted.

Although much of the information we are providing here regarding those benefits is publicly available, we understand it can be helpful to have in one place. Additionally, we are providing as part of this statement comments about the qualifications of the descriptions of those benefits (what it does and does not include) as well as a description of our organization and its past and current strategy development and activities with respect to wind energy since 2014.

1.1 Table of Contents

1.2 Content Outline

The first main part of this statement (Section 2 – Projects & Benefits) will provide information on the companies (Section 2.1), the projects (2.2), economic impact studies (2.3), tax revenue (2.4), jobs (2.5), comparable projects (2.6), and aggregate numbers. This is done using a traditional economic development approach.

The second main part of this statement (Section 3 – Considerations) will provide comments on what is and (more importantly) what is not included and/or discussed in the first main part (Projects & Benefits), as well as caveats and qualifiers. It discusses benefits versus costs (3.1), incentives (3.2), different types of benefits (3.3), temporary v. long-term benefits (3.4), geographic consideration (3.5), sophistication level of the analysis (3.6), information availability and stability (3.7), as well as our best efforts (3.8).

The third main part of the statement (Section 4 – Organizational Context) provides comments on the Tiffin-Seneca Economic Development Partnership and its interaction with strategy and activity connected with wind energy. It differentiates between community and economic development (4.1), discusses the current community development plan (4.2), describes the Tiffin-Seneca Economic Partnership (TSEP, formerly SIEDC) (4.3), discusses the current "Comprehensive Economic Development Strategy" (CEDS) generally (4.4), discusses the CEDS on wind specifically (4.5), and provides a sense of how TSEP uses the CEDS as well as a quick outline to the strategy developed and some activities performed since 2015 (4.6).

2. Projects & Benefits

2.1 Company Descriptions

We often do profiles and basic research on the companies looking to do projects, and here is some basic information on the companies together with excerpts of an article for each on the companies' activities in northwest Ohio.

Apex Clean Energy

- "Apex Clean Energy, Inc. builds, owns, and operates utility-scale wind and solar power facilities. The company provides facility layout, turbulence, wake, development cycle, pre-development, construction contracting, interconnection design, transmission system design, site civil design, systems engineering, geotechnical, turbine selection, procurement, project financing, interconnection agreement, and power purchase agreement services. It offers its services in Kansas, Colorado, Wyoming, New York, and Texas, as well as in the Netherlands. The company was founded in 2008 and is based in Charlottesville, Virginia. Apex Clean Energy, Inc. operates as a subsidiary of Apex Clean Energy Holdings, LLC." (Bloomberg)
- "Apex Clean Energy is a renewable energy firm that develops commercial-scale wind and solar energy facilities. Apex Clean Energy's headquarters is in Charlottesville, Virginia. Apex Clean Energy has a revenue of $15M, and 232 employees. Apex Clean Energy has raised a total of $519.3M in funding. Apex Clean Energy's main competitors are Invenergy, Geronimo Energy and Terra-Gen. As of December 2018, Apex Clean Energy has 2.7K fans on Facebook and 387 followers on Twitter." (Owler)
- The company has 64 renewable energy projects listed on their website, of which ten are solar and the remaining wind. Ten of those projects are in the Midwest and three in Ohio (Emerson Creek Wind (listed as Erie and Huron Counties), Emerson West Wind (Seneca County), and Republic Wind (Seneca County). (Apex)
- Recent News affecting Ohio – Excerpts from S&P Global Intelligence (November 14, 2018), "Apex Clean Energy cancels Ohio wind project; suit filed over setback law."
    - Citing an unfriendly business climate for wind energy development in Ohio, private developer Apex Clean Energy Inc. has backed away from plans to build the Long Prairie Wind project.
    - The 600-MW wind farm planned for Van Wert and Mercer counties was to be complete in November 2022, according to S&P Global Market Intelligence data. The company said in a statement that Ohio's current policy environment "creates unnecessary market barriers for wind energy" and has made investment in the state a "highly risky proposition."
    - Wind energy advocates have blamed a 2014 state law that nearly tripled the property line setback distance to roughly 1,300 feet for slowing wind farm development in the Buckeye State. Attempts to ease the siting rules have failed, and Democratic gubernatorial candidate Richard Cordray, who wanted to do away with the requirement, lost the Nov. 6 election to Republican Mike DeWine, the state's attorney general.
    - Apex Clean Energy said its Ohio portfolio would provide hundreds of millions of dollars in local revenue and school funding to the state along with a low-cost power source. "Unfortunately, the state's current anti-business policies are making it necessary for us to reduce our investment exposure in the state and to choose which of our projects we continue to advance in Ohio."
    - The company also pointed to challenges presented by the transmission system around Van Wert and Mercer counties, in western Ohio bordering Indiana, for the decision to shelve the project. Apex Clean Energy said the decision will allow the company to direct more attention and resources to other Ohio projects, which include the 300-MW Emerson Creek Wind Project and 150-MW Firelands Wind Farm in Huron County, and the 197.4-MW Emerson West Wind Project and 198-MW Republic Wind Farm in Seneca County. The neighboring rural counties are in northern Ohio."

sPower

- sPower, an AES and AIMCo company, is the largest independent solar developer in the United States. Headquartered in Salt Lake City with offices in San Francisco, Long Beach and New York City, sPower owns and operates more than 150 utility and commercial distributed electrical generation systems. sPower has deployed more than $2 billion of capital for its solar and wind projects. With more than 13 GW between operating, construction and pipeline, sPower is actively buying select utility-scale renewable assets in virtually any stage of development in the United States. (Business Wire)

- sPower, an AES and AIMCo company, is the largest private owner of operating solar assets in the United States. sPower owns and operates a portfolio of solar and wind assets greater than 1.3 GW and has a development pipeline of more than 10 GW. sPower is owned by a joint venture partnership between The AES Corporation (NYSE: AES), a worldwide energy company headquartered in Arlington, Virginia, and the Alberta Investment Management Corporation, one of Canada's largest and most diversified institutional investment fund managers. (sPower)
- sPower develops, owns and operates utility and commercially distributed electrical generation systems for developers and landowners. sPower was founded in 2012. sPower's headquarters is located in Salt Lake City, Utah, USA 84106. It has raised 1.3B in 3 rounds. The latest round was in Nov 2016. Some of sPower's investors include CIT Bank, CoBank ACB and Rabobank. sPower's CEO, Ryan Creamer, currently has an approval rating of 97%. 100% of the Owler community believes sPower will IPO. sPower has an estimated 250 employees and an estimated annual revenue of 30.0M. (Owler)
- The company has more than 150 renewable energy projects, with 66 operational US utility energy and 53 US distributed generation projects listed on their website. Two of the utility energy projects are wind and the rest are solar. None are in Ohio. (sPower)
- Recent News affecting Ohio – Excerpts from Norwalk (Ohio) Reflector (Nov. 21, 2018), "Plans unveiled for Emerson Creek Wind Farm near Norwalk"
    - Plans for the massive Emerson Creek Wind project — in the works since 2009 — were unveiled to the public last week during an open house at the Bronson Norwalk Conservation League.
    - Apex is the developer of the Emerson Creek project and the Republic Wind project being developed mostly in Seneca County and in Sandusky County's York Township. It also is the developer behind a project scheduled to be unveiled a year from now, the Honey Creek wind farm that'll be proposed mostly for Crawford County and a small part of Seneca.
    - Seneca also is home to the Seneca Wind project proposed over five of that county's townships by Utah-based sPower.
    - Each of the projects consists of about 65 to 85 turbines. Republic Wind and Seneca Wind are both expected to have the capacity to produce 200 megawatts of power. About 1,000 homes can be powered for every megawatt of electricity, depending of course on the size of homes and the time of year. And just because a wind farm has a capability of generating 200 mw doesn't mean it always will.
    - That doesn't make it Ohio's largest, but it puts it near the top of the list with others, such as the Blue Creek Wind Farm in Paulding and Van Wert counties, which has a rated capacity of 304 mw, and one in Hardin County that has a rated capacity of 300 mw. A cluster of four on Timber Road in Paulding County have a combined rating of nearly 425 mw generated by 182 turbines.
    - About three-quarters of the Emerson Creek project falls within Huron County, and most of the rest is planned for Erie County.
    - Only three of an expected 84 turbines associated with that project are expected to be in Seneca County, (Apex's John) Arehart said.
    - Apex wants to begin erecting Emerson Creek turbines in early 2020 and have them operational by the fall of that year, then have its Honey Creek project operational by the end of 2021, Arehart said.
    - A revised version of the Republic Wind project will be released at an open house in December, Montague said.
    - Matt Butler, Ohio Power Siting Board spokesman, said an administrative judge is setting dates for the Seneca Wind hearings, which are expected to be in January. Emerson Creek's formal application must be made to the siting board within three months now that Apex has had an open house.
    - Once the applications are in hand, the power siting board typically gives projects six to nine months of review before commencing hearings, he said.

2.2 Key Project Numbers

The two projects being considered in this statement are the Apex Republic Wind project and the sPower Seneca Wind project. The Emerson Creek and Honey Creek projects are not being discussed here.

Apex Republic Wind (from OPSB filing, December 2018)

- Investment: $400 million investment (this figure from Republic Wind website; project-specific information kept confidential in all applications submitted to the OPSB, including the most recent)
- 50 turbines, not to exceed 200MW, over a 24,000-acre project area
- 30-year commitment
- 10 long-term operations jobs
- Started by Apex in August 2010
- Amended application filed with the OPSB in December 2018
- Construction to begin October 2019, if approved

sPower Seneca Wind (from 2018 OPSB application and website)

- Investment: $280 million ($175 million in turbines, $60 million in construction and electrical materials, $30 million in labor, $15 million in project development costs)
- 85 turbines, generating 212MW, located within 56,900 acres
- 30-year commitment
- 8-10 long-term operations jobs
- Acquired from Exelon in 2017, who had purchased it from John Deere previously
- Application filed with the OPSB in July 2018
- Public hearing scheduled February 19, 2019; adjudicatory hearing scheduled March 6, 2019
- Construction would have been slated to begin in Q2 of 2019, if the OPSB would have issued a certificate in December 2018.

2.3 Economic Impact Studies

Both projects have economic impact studies as part of the application, and we are mentioning them here and summarizing the results.

Apex Republic Wind (p.25 of Appendix G)

- Syracuse, New York-based EDR Environmental Services performed the analysis using the National Renewable Energy Laboratory's (NREL's) Jobs and Economic Development Impact (JEDI) Land-based Wind model. It was completed in December 2018.
- Conclusions (p. 25 of Appendix G):
  - The socioeconomic effects of the Republic Wind Farm, when assessed in light of regional and local economic trends, will have a positive impact on the communities within the Study Area and across the State of Ohio. Lease payments, short- and long-term job creation, and PILOT revenues will benefit private landowners, businesses and taxing jurisdictions. The Facility is not expected to generate significant expenditures on behalf of these beneficiaries; therefore, it will have a positive impact on the social and economic conditions of these communities and across Ohio.
  - 1. Total Statewide Economic Benefit: The construction of the Republic Wind Farm is expected to produce $41.1 million in employment earnings and $112.2 million in total economic output. Subsequently, each year the Facility is operational it is expected to generate approximately $2.3 million in earnings and $5.9 million in total economic output.
  - 2. Statewide Employment Benefits: During the construction period, the Facility is expected to support demand for a total of 753 onsite, supply chain, and induced employment positions. It is expected to support a total of 41 positions during each year of its operation.

  - 3. Land Lease Revenue: The development of the Facility will result in $[Redacted] in annual lease payments made to participating landowners.
  - 4. Property Tax Revenues: Construction of the proposed Republic Wind Farm will increase local government revenues through payments in lieu of taxes (PILOTs). Though the agreements outlining these payments are not yet finalized, it is estimated that annual PILOT revenues could amount to approximately $1.2 million to $1.8 million to be distributed to local taxing jurisdictions."

sPower Seneca Wind (pp. 35-38, Study Appendix C)

- Matt Dadwell of Pasadena, California-based Tetra Tech did the economic impact analysis on behalf of sPower for the application using the National Renewable Energy Laboratory's (NREL's) Jobs and Economic Development Impact (JEDI) Land-based Wind model.
- Conclusions (p. 12 of Appendix C):
  - "The preceding analysis estimates the economic and fiscal impacts associated with construction and operation of the proposed Project at the local (Seneca County) and state levels. Impacts were estimated for each geographic area, state and county, using separate JEDI Wind Models. The results of this analysis indicate that construction and operation of the Project would provide direct employment for residents in Seneca County and elsewhere in-state, as well as support economic activity elsewhere in the local and state economies.
  - Overall, construction of the Project is estimated to support 795 total (Project Development and On-Site, Turbine and Supply Chain, and Induced) jobs in the State of Ohio, and approximately $46.7 million in labor income, with total economic output of approximately $132.6 million. In Seneca County, Project construction is estimated to support approximately 49 total jobs and approximately $2.4 million in labor income, with total economic output of approximately $7.6 million. Construction impacts would be one-time impacts that would occur only during construction.
  - Operation of the Project is estimated to support approximately 39 total (direct, indirect, and induced) jobs in the State of Ohio and approximately $2.4 million in labor income, with total economic output of approximately $7.8 million. In Seneca County, Project operation is estimated to support approximately 27 full-time jobs and approximately $1.2 million in labor income, with total economic output of approximately $4.6 million. These annual average impacts are expected to occur over the life of Project operation.
  - Seneca Wind anticipates that it will make payments in lieu of real and personal property taxes in accordance with the applicable statute (ORC 5727.75) and the Board of Seneca County Commissioners' Office 2011), with the Project estimated to generate $1.91 million in PILOT payments during its first year of operation, and each year thereafter. Seneca Wind also estimates that lease payments to landowners will total more than $20 million over the life of the Project."

2.4 Tax Revenue Generation

The Seneca County Auditor did an analysis in May 2018 with information provided from John Moran, then Project Manager for sPower, and Dalton Carr with Apex Clean Energy. The calculation sheets have been attached to this document, and the numbers have been interpreted below. The totals, even though the project information may have changed, line up with the estimates in the OSPB application. It is worth noting that according to the Ohio Department of Education via the Seneca County Auditor, the PILOT payments below do not impact any of the schools' funding formula. In addition, with two economic development organizations with which we spoke, they verified that the anticipated revenue came in.

Taxing District	Republic Wind Annual ($ dollars)	Republic Wind 30 Years ($ dollars)	Seneca Wind Annual ($ dollars)	Seneca Wind 30 Years ($ dollars)	Both Projects Annual ($ dollars)	Both Projects 30 Years ($ dollars)
$1K to General Revenue Fund	196,020	5,880,600	205,310	6,159,300	401,330	12,039,900
County General Fund	48,331	1,449,930	50,367	1,511,010	98,698	2,960,940
Opportunity Center	221,303	6,639,090	230,628	6,918,840	451,931	13,557,930
Bellevue Schools	325,001	9,750,030	-	-	325,001	9,750,030
Buckeye Central LSD	-	-	301,119	9,033,570	301,119	9,033,570
Clyde EVSD	60,588	1,817,640	-	-	60,588	1,817,640
Mohawak LSD	-	-	273,828	8,214,840	273,828	8,214,840
Old Fort LSD	81,178	2,435,340	-	-	81,178	2,435,340
Seneca East LSD	511,470	15,344,100	475,237	14,257,110	986,707	29,601,210
EHOVE Career Center	34,765	1,042,950	-	-	34,765	1,042,950
Pioneer JVSD	-	-	22,508	675,240	22,508	675,240
Vanguard JVSD	28,199	845,970	32,680	980,400	60,879	1,826,370
Adams Twp	46,112	1,383,360	-	-	46,112	1,383,360
Bloom Twp	-	-	38,933	1,167,990	38,933	1,167,990
Eden Twp	-	-	30,463	913,890	30,463	913,890
Pleasant Twp	6,133	183,990	-	-	6,133	183,990
Reed Twp	16,393	491,790	27,037	811,110	43,430	1,302,900
Scipio Twp	32,777	983,310	6,230	186,900	39,007	1,170,210
Thompson Twp	56,998	1,709,940	-	-	56,998	1,709,940
Venice Twp	-	-	14,865	445,950	14,865	445,950
Health District	7,632	228,960	7,952	238,560	15,584	467,520
Bellevue Library	7,813	234,390	-	-	7,813	234,390
Birchard Library	1,202	36,060	-	-	1,202	36,060
Mohawk Library	-	-	5,415	162,450	5,415	162,450
Seneca East Library	11,023	330,690	10,243	307,290	21,266	637,980
Tiffin-Seneca Public Library	1,725	51,750	-	-	1,725	51,750
Commission on Aging	7,632	228,960	7,952	238,560	15,584	467,520

Mental Health & Recovery	17,807	534,210	18,556	556,680	36,363	1,090,890
County Park District	12,719	381,570	13,255	397,650	25,974	779,220
Attica Venice Cemetery	-	-	4,054	121,620	4,054	121,620
AVR Fire District	16,145	484,350	41,267	1,238,010	57,412	1,722,360
AVR Jt Ambulance District	7,452	223,560	19,047	571,410	26,499	794,970
Bloom-Scipio Amb District	7,766	232,980	10,844	325,320	18,610	558,300
Tax District Totals	1,568,164	47,044,920	1,642,480	49,274,400	3,210,644	96,319,320
Revenue Totals	**1,764,180**	**52,925,400**	**1,847,789**	**55,433,670**	**3,611,969**	**108,359,070**

2.5 Jobs

The maintenance and operation jobs, while not large in number compared with the investment, are very much worth mentioning, especially given the level of wages:

	Republic Wind	Seneca Wind	Total – Annual	Total – 30 Years
Operation Jobs	10	11	21	21
Anticipated Payroll	$ 600,000	$ 590,000	$ 1,190,000	$35,700,000
Average Salary	$ 60,000	$ 53,636	$ 56,667	
Average Wage	$28.85	$25.79	$27.24	

2.6 Comparisons to Other Projects

It might be helpful to compare these projects to other industrial projects for the sake of comparison. A couple of random examples provided here might be illustrative. Other projects can be found on our website at www.tiffinseneca.org.

AFS 2014 Expansion

- $16 million expansion at the Tiffin plant
- $8 million into a plant expansion; $8 million into new equipment
- 24 new jobs (140 maintained); $700,000 estimated new annual payroll.
- Community Reinvestment Area tax exemption on new construction; 100%, 15 years
- $191,000 estimated real property taxes, years 16-30. $2.87 million estimated over 30 years.
- No taxes on tangible personal property (equipment).

Church & Dwight 2016 Expansion

- $2.5 million expansion
- No new construction. New equipment and rail infrastructure.
- 20 new jobs (215 maintained); $830,000 estimated new annual payroll.
- JobsOhio provided $170,000 in a Roadwork Development Grant; the Ohio Tax Credit Authority provided a $75,000 Ohio Jobs Creation Tax Credit; the Ohio Rail Development Commission provided a $100,000 grant.
- No new property taxes.

2.7 Aggregate Numbers (2014-2017)

Also for context, it is worth mentioning that Seneca County has placed in the top ten percent of the country for economic development for three of the last five years (2014-2018) and in the top ten percent the other two years. This is a ranking of non-metro counties (576 in the US) and the number of significant private investment projects announced or completed in a year ($1 million or above in investment, 20 or more employees, 20,000 or more square feet of new construction). In the 2014-2017 time frame, we saw $335 million in new investment and 1,400 new jobs. 2018 results have not yet been tabulated.

3. Considerations and Caveats

In addition to describing the context of the statement, both strategically and organizationally, it is also important to provide information on what this statement looks to provide and, very importantly, what it does not look to provide, so that it can be understood appropriately.

3.1 Benefits vs. Costs

The first qualifier of this statement is that it does not do any analysis of the "economic development costs," which is typical of economic development organizations. This is because historically, from a tax perspective, commercial and industrial development have been viewed as positive (use less in taxpayer-funded services than they provide in taxes), whereas residential has traditionally been viewed as negative (using more in services than they pay for in taxes.) This isn't to say that residential development is a "bad thing," it is often considered a very positive thing. It just doesn't typically "pay for itself." This is one of the reasons the public sector has helped fund economic development using taxpayer dollars, as private sector economic development generates additional net positive public tax dollars from the private sector to pay for public services used by residents and businesses. This also doesn't mean that businesses don't use public services and that different types of business use different amount of services. An assisted living facility, for example, typically uses more EMS services than an industrial development. With a low number of employees, wind energy uses much less in EMS and other services in this regard. Another example of a cost is the impact of a project on other businesses, such as in the case of other restaurants when a new restaurant appears. We do not focus on these costs in this statement.

3.2 Incentives

Another type of "cost" often involved in economic development projects are incentives. A fundamental assumption that economic development organizations make with respect to tax incentives are that the tax incentives are a major factor and/or necessary in order to make the project move forward. In that sense, with very few exceptions, they are "exemptions" and not "abatements," meaning that there is not any existing tax revenue from the land is "foregone." Instead, it is new revenue that is being "exempted" that wouldn't exist but for the project. In the case of grants (which do not apply here) and other incentives, some organizations (such as JobsOhio) run Return on Investment calculations to determine when they "break even," and when their projected net revenue is going to be over a certain term. Most economic development organizations with which we are familiar do not perform this kind of analysis.

Another aspect not considered or discussed here is the amount of the incentives, in this case the amount of the payment-in-lieu-of-taxes (PILOT) to be paid by the wind projects. Per discussions with the companies and in our estimation, these projects would likely not have developed without the Alternative Energy Zone (AEZ) incentive area put in place in Seneca County prior to 2012. The AEZ provides a pre-determined tax incentive level for any project that is appropriately qualified by the Ohio Development Services Agency. In addition, whether a different amount could have and/or should have been negotiated after the projects moved forward is a policy consideration not deemed within the scope of TSEP and therefore also not discussed here.

3.3 Types of Benefits

The second qualifier of this statement is that TSEP typically focuses on direct benefits and not indirect or induced benefits. This is also not atypical for economic development organizations, but it should be noted that economic modeling tools exist—and have been employed in this case by the wind companies—which seek to describe indirect and induced benefits (e.g., JEDI, IMPLAN). This qualifier differentiates between the different types of benefits economic impact models typically identify - direct, indirect, and induced benefits.

- Direct economic benefits (or impacts) are those which come from the expenditures directly related to the construction and operation of a business – jobs (wages and benefits for construction and operation of the facility), fixed capital asset investment (land, building, equipment), materials and supplies.
- Indirect benefits are the economic benefits created by businesses supplying the original business (their suppliers).
- Induced benefits are the economic benefits created by employees of the original business purchasing goods and services for themselves and their household.

With wind development, landowner payments that cycle back into the economy (they are a supplier of land) can be considered indirect economic benefits. For example, Apex has made public on their website that the Republic Wind project will provide $29 million in landowner payments. These are also not a focus of this statement. The project's application with the Ohio Power Siting Board does require an expert analysis of these benefits, so they will be mentioned in the Benefits section for additional context, and the studies is attached.

3.4 Temporary vs. Long-Term

Apex currently has on their website that the Republic Wind project will create 100 construction jobs. Construction jobs provide a direct economic benefit, but TSEP does not report on these jobs and their impact for a few reasons, the most important of which is that they are temporary. It does not mean that they are not important, just that they are only supported by the project for the time during construction. Most of our own analysis looks at a ten, twenty, or thirty-year time horizon, and this is typical for how we talk about the economic impact of other commercial and industrial projects. We are applying the same logic here. The project's application with the Ohio Power Siting Board does require an expert analysis of these benefits, so they will be mentioned in the Benefits, and the studies are attached.

3.5 Local vs. State/Federal

In addition, locally we do not consider statewide or federal impacts in what we discuss regarding specific projects, as generally those impacts do not affect the local economy in ways we can measure. For example, we do not report on statewide spinoff jobs, nor do we report on Ohio CAT (Consumer Activities Tax), income or sales tax. We do report on municipal income tax, property tax, and local sales and use tax. The project's application with the Ohio Power Siting Board does require an expert analysis of these benefits, so they will be mentioned in the Benefits section for additional context, along with the firm doing the study.

3.6 Simplified Estimates

This statement does not intend to provide a detailed tax analysis, but to provide basic information for the Commissioners' considerations. It also does not do net present value calculations on these benefits. It assumes the company and project will continue to pay its tax or payment-in-lieu-of-taxes (PILOT) obligations for the term of their commitment, which is also typical. We understand this is an assumption.

3.7 Information Availability & Stability

Project information can change over time. This, too, is not unusual with longer-term projects, which industrial wind turbine developments tend to be. The nature and cost of the equipment purchased and investment to be made; the anticipated job numbers, types, and payroll can change. Some information is made publicly available, and some is not. We will be using publicly available information for this statement. The amount of the investment for the Republic Wind project, for example, has been redacted from the application submitted to OPSB, so we are using the best available public information to our knowledge, which is from their website.

3.8 Best Efforts

We have used best efforts to put together some useful information for the Seneca County Commissioners at their request. We do not have access to sophisticated modeling, nor do we have expertise or ability to assess larger picture impact of this or any other industry and projects. We make no claim that this information has undergone rigorous vetting by economic modelling experts and/or that it encompasses all the various aspects involved in assessing the costs and benefits of these or any other particular developments. We also do not claim to be experts in tax matters and have either used our best efforts to estimate potential financial impacts and/or worked with other officials (e.g., Seneca County Auditor) to quantitatively assess impact.

4. Organizational Context

4.1 Community Development

One thing this document does not do is provide information on the community development impact and/or overall community costs and benefits of wind. This is not a function we perform within Seneca County generally. For purposes of clarification, it might be helpful to differentiate between economic and community development. Economic development can generally be understood as private businesses investing private capital for a private purpose (generally profit), resulting in the creation and/or retention of jobs.

Community development can generally be understood as the investment of public and/or private capital for a public and/or non-commercial purpose. Understood this way, community development is a much larger umbrella concept, which includes (among other things) things such as housing, environment, education, utilities, infrastructure, open space and recreation, and housing. The current plan in use is the 2001 Seneca County Comprehensive Plan Update (CPU), and it was facilitated by and managed by the Seneca Regional Planning Commission (SRPC). The SRPC is currently leading an effort to update the plan. Community development planning also informs but does not determine public community development policy, the determination of which is the role of government and elected representatives at various levels.

4.2 Comprehensive Planning

The CPU that is currently in place was adopted by the Seneca County Commissioners on April 7, 2001. The Columbus, Ohio-based firm Burns, Bertsch & Harris created the plan, and the SRPC, together with other stakeholders, contributed to its development. These plans are expected to have a 20- to 30-year life, and a new plan is currently being facilitated by the SPRC and created by CT Consultants. Section.6 of the current CPU discusses economic development in general terms, and it lists attraction as one of the strategies with the general comments, "Broaden and diversify the economic base of the County by seeking an appropriate mix of industrial, commercial, and office uses" (p. 6.11). This is further articulated in Section 9 (Strategic Implementation), as Strategy 1.1 "Increase the economic development potential of the County," and the sub-strategy 1.1.c "Broaden and diversify the economic base of the County by seeking an appropriate mix of industrial, commercial, and office uses." The plan does not mention wind or renewable energy specifically.

It does capture some principles in its goals in Section 3 (Goals and Objectives), and again in Section 9. Goal 1 is to "Maintain and enhance the standard of living for all citizens of Seneca County" (p. 3.1), and it includes along with economic development (Strategy 1.1, p. 3.1), other elements such as housing (Strategy 1.2), open space and recreation (Strategy 1.3), historic preservation (Strategy 1.4), and maintaining the rural character of the county (Strategy 1.5). Goal 2 is to "Encourage growth that focuses upon existing urban areas and respects intrinsic values of the land" (p. 3.2). It includes encouraging growth within municipalities only (2.1), using growth management principles (2.2), farmland preservation (2.3), environmental protection (2.4), and intergovernmental cooperation (2.5). The third goal addressed infrastructure.

4.3 Tiffin-Seneca Economic Partnership

In contrast to the SRPC, the Tiffin-Seneca Economic Partnership (TSEP) is a 501c3 nonprofit created specifically in 1983 to promote economic development in Tiffin and Seneca County, Ohio, and that purpose continues to be a driving force of its day-to-day mission, which is to facilitate economic development projects in Tiffin and throughout most of Seneca

County, as well as downtown and community development projects within the City of Tiffin. We fulfill that mission using the strategic foundation of the 2011 Comprehensive Economic Development Strategy (CEDS), according to priorities determined annually by our members, and within strategic guidelines set every year by our Board of Trustees.

4.4 Comprehensive Economic Development Strategy (CEDS)

Unlike the much broader and community development oriented Comprehensive Plan Update, the CEDS is focused exclusively on economic development. The most current version (2011) replaced the previous CEDS developed in the mid-1980s and commented specifically on its purpose in the document: "This strategy is intended to position Seneca County as a 'redevelopment area', as defined by the EDA (US Dept. of Commerce Economic Development Administration), and thus to make its political subdivisions eligible to apply from the EDA Public Works and other programs." It had the secondary function of providing a "demographic and marketing profile." The CEDS committee was made up of the following people, representing a cross-section of public- and private-sector leaders in Seneca County at the time.

4.5 CEDS and Wind Development

Although the CEDS was primarily created to fulfill federal requirements in order to enable the community to pursue federal funding, it does provide a strategic framework for economic development activities and is therefore relevant to context. Importantly, it became the basis for TSEP (SIEDC at that time) strategic planning.

The CEDS does reference wind development. On page 38, one of the opportunities to grow the regional economic identified was "green business and practices, including development of wind farms and solar cells," which then was made into an objective in Goal 2 ("Attract new, diversified business activity to Seneca County"). This objective (Objective 2.2) was "Target and devote resources to new and growing markets and new lines of business that are most likely to succeed," one of six markets appearing there was "green business and wind energy." Page 63 mentions "the potential development of wind farms within the County in the near future" (p. 63), which then is more fully explained as Priority 5 under "Current Priorities," where it appears as "Preparation of County for Wind Farms."

That section is worth reprinting here in its entirety: *"There has been considerable recent discussion of the development wind farms, involving a significant number of large wind turbines located on currently agricultural or non-productive property in Seneca County. Several companies have discussed wind farm development involving sixty to eighty turbines, in both the eastern and western portions of the county, with construction crossing county boundaries into Hancock County to the west and Sandusky Counties to the east.*

"While firm plans have not been made public, wind farm developers have been planning for their eventual development, and the County Commissioners have approved a resolution which makes the county an 'alternative energy zone' allowing wind, solar, and other energy companies eligible for state tax incentives. Preparation for these projects may require upgrading of local roadways to accommodate trucks. Thus, while the lack of firm plans makes public improvement planning difficult, the imminent development of these wind farms will undoubtedly require public improvements in the short term, to provide adequate transportation routes for the transport of turbine components. Design and funding for public improvements will likely be determined within a very short period of time, once projects and private investments are announced" (p. 69).

4.6 Strategy Development

In 2014, the CEDS, already three years old (and most strategic plans are built to be three- to five-year documents), was starting to approach the end of its "useful life" as literal roadmap. In order to extend its life and make it useful within a current context, TSEP developed a process whereby every fall the members would prioritize the nine goals of the plan, the Board would then evaluate the overall direction of the organization, and then the Board would spend some time thinking about the top priorities for next year. Out of this, the TSEP staff would create next year's scope of work and associated budget, which would then be discussed and approved by the Board of Trustees. This annual scope of work would, in essence, represent a current and workable tangible and actionable expression of the strategic plan.

This process has been followed every year, with strategic guidelines and a scope of work being developed preceding the calendar year of activity. The following is a quick summary of the strategy developed through that process (in the preceding fall) as well as some of TSEP's (SIEDC's) activities during that year. The activities are included here (versus in another section) because it is easier to review them here in their strategic context:

2015

- Strategy - During the first year of the planning process (fall 2014), the members selected attraction (Goal 2) as the second most important goal for 2015, and the Board selected Objective 2.2 ("New Markets and Clusters") as the most important objective within that goal.
- Activities - TSEP's interface with the industry and the projects began in 2015, when we were first contacted by Apex to discuss proposed changes to setback requirements contained in House Bill 483, passed in 2014. Given the CEDS, the support of local state legislators like Bill Reineke, the limited nature of our participation, and the fact that it appeared this was needed to facilitate the project, we started to work on it.

2016

- Strategy - The following year (fall 2015), attraction was again ranked by members as the second most important goal. The metrics (strategies) picked for that year were attraction trips, cluster report and top 20 incentives information. The top four industries identified for attraction were: food processing and agribusiness; automotive; industrial machinery and equipment; and educational services.
- Activities
    - SIEDC met periodically with Apex officials to receive updates.
    - On April 3, SIEDC wrote a letter of support "to whom it may concern" for the Republic Wind project. The economic development benefit paragraph read: "The purpose of SIEDC is to help create and retain jobs and investment in Tiffin and Seneca County, and over the past thirty years, we've made a lot of progress. Republic Wind represents immediate and long-term benefits for Seneca County in both of our target areas. The construction phase will create hundreds of jobs and infuse millions of dollars in investment into the county. During operations, the community will benefit from sustained tax revenue to the county for local governments and schools, plus decades of procurement, jobs, and investment."

2017

- Strategy - Attraction was ranked the highest goal, with cluster plans (based on the aforementioned industries), a resource directory, and a cluster trip as the three top strategies, along with a resource expo and three retail attraction strategies.
- Activities
    - Continued to work with Apex providing any requested traditional economic development services.
    - June 7 - David Zak, along with economic development directors from Paulding, Fulton, Van Wert, Licking, Putnam and Medina Counties, spoke with state legislators about the economic development benefits of wind.
    - October 18 – gave testimony to the Ohio Senate in favor of changing setbacks. From the testimony: "It (Apex Republic Wind project) would create hundreds of jobs during construction and infuse millions of dollars in into the county. During operations, the community will benefit from sustained tax revenue for local governments and schools, plus benefit from decades of procurement, jobs, and investment."

2018

- Strategy – in the fall of 2017, attraction fell to third, and the following strategies were identified specifically: branding, targeted industries, foreign direct investment, and university collaboration. In recognition of our previous activities and in order to ensure board support for Metric R read as follows: "We will continue to be a strong advocate for modifying the current wind turbine setback regulations in order to allow Apex and potentially other wind energy providers to invest."
- Activities
    - Continued to work with Apex and started working with SPower to provide any requested traditional economic development services.
    - We met with S-Power for the first time during 2018.
    - On April 11, we joined Ohio Rep. Bill Reineke, along with the Paulding County Chamber and Paulding County Economic Development, Seneca East Local Schools, and Seneca County Commissioner Holly Stacy, and others to comment on a new report "A Tale of Two Projects," which outlines the benefits of wind projects to Paulding County and how Seneca County has not been able to realize them.
    - In May, we started working on a paper describing the economic development benefits of wind. In the following months, we continued to get additional information regarding
    - In June, local state legislators stated they were not in support of changing the setback legislation and would not pursue it. In response, the SIEDC Board of Trustees affirmed SIEDC would continue to provide traditional economic development services for wind project, while no longer continuing to pursue a strategy of advocating changing legislation in order to help facilitate the project given the limits of our ability to advocate according to our legal counsel and given the lack of local state legislative support.
    - On July 25, we held our semi-annual Member Briefing, and one point of the presentation mentioned some of the challenges SIEDC faces as an organization, including in working with the wind industry. We affirmed that we would provide traditional economic development services in a nondiscriminatory way to all legal businesses, including the wind industry. This does not include legislative advocacy, which is not a traditional economic development service. We made this same presentation publicly to Tiffin City Council and the Seneca County Commission.
    - In the fall of 2018, we assisted SPower find an office in downtown Tiffin, and we attended the ribbon cutting for the office on December 13. We also shared a press release they had prepared, as we traditionally do with all businesses.
    - December – we drafted this document on our historical strategy, activities and economic development benefits.

2019 (next year)

- Strategy
    - In the Fall 2018 Member Survey, attraction (Goal 2) fell to fourth and then was not discussed in-depth at the annual board retreat, which focused on brainstorming for the top three priorities (workforce, infrastructure, and retention and expansion). The resulting approved scope for next year is very operational and tactical in nature, with improved service delivery, improved stakeholder management, and more resources being the three overarching goals.
    - It is worth mentioning that the Board approved the following delineation of our mission – what we do and what we do not do: "The mission of TSEP (what we do to fulfill our purpose) is to facilitate projects. We do work on other activities, but they all in some way help us facilitate more projects and/or facilitate them more effectively. Accordingly, TSEP will not (as a general rule) manage community events, participate in legislative advocacy, take on any new intensive grant administration (without additional resources), take on controversial positions, and/or serve as a 501c3 'umbrella' organization for community events and initiatives."
- Activities – start on January 2, 2018, but they will include providing traditional economic development services to Apex and SPower.

4.8 Official Statements

Since 2014, the TSEP (SIEDC) Board of Trustees has not made or approved any official public statements supporting or opposing any particular industry on its merits or any particular projects in terms of their overall and/or community development impact. It has, though, consistently affirmed a neutral and nondiscriminatory approach to providing traditional economic development services to all legal businesses.

5. Conclusions

The two projects under consideration would potentially generate a significant amount of tax (PILOT) revenue - $108 million over 30 years and they would create almost 20 new, full-time jobs paying almost $60,000 per year. Caveats and qualifiers about this statement are described throughout this document.

The Tiffin-Seneca Economic Partnership (TSEP) has been assisting the facilitation of the wind projects since at least 2015. It has been involved with the Comprehensive Economic Development Strategy and used it as a strategic foundational document since the fall of 2015, along with many others, that targeted wind energy and assisted in the creation of the Alternative Energy Zone (AEZ) in October of 2011. That AEZ has attracted wind development and has resulted in the current two (and potentially more) project moving forward. It is our view that without the AEZ, those projects would not have come to Seneca County.

We sincerely hope that this statement and the information contained therein is beneficial, helpful and meets your needs. In addition, if more specific or expert is desired, we would be happy to work with you as appropriate to identify additional ways that additional information could be provided or procured, including, but not limited to, identification of consultants with needed expertise, the creation of a Request for Proposal (RFP) and/or management of the RFP and selection process, and management of a study.

EXHIBIT G. Socioeconomic Report

Socioeconomic Report

Republic Wind Farm

Adams, Pleasant, Reed, Scipio, and Thompson Townships, Seneca County and York Township, Sandusky County

Prepared for:

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December 2018

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EXECUTIVE SUMMARY

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The focus of this report is to assess the potential socioeconomic impacts of this Facility on local municipalities within a 5-mile radius from the Facility ("the Study Area"; see Figure 1), as well as across the State of Ohio. This involves a review of the past and current demographic and economic characteristics and trends in the Study Area, which includes 23 municipalities, and (where applicable) those of the greater region. The regional economy surrounding the Study Area is shaped in large part by the agricultural industries of Erie, Huron, Sandusky, and Seneca Counties as well as the metropolitan areas in northern Ohio and further afield. Potential impacts including those to employment, earnings, and overall economic output resulting from Facility construction and operation are assessed in light of socioeconomic conditions within the State of Ohio and the Study Area.

In short, the Republic Wind Farm is expected to produce a positive economic impact throughout the state and on the communities within the Study Area. Through lease payments to private landowners, short- and long-term job creation, and tax payments to each participating taxing jurisdiction, the Facility will supply a revenue stream to each of these jurisdictions without requiring significant services or expenditures on their behalf.

Part I: Introduction

This socioeconomic report is prepared in support of the proposed Republic Wind Farm ("the Facility"), a wind-powered electric generation facility in Sandusky and Seneca Counties of the State of Ohio (See Figure 1). The Facility will consist of 50 turbines, along with access roads, electric collection cables, a Facility substation, laydown yards for construction staging, an operations and maintenance (O&M) facility, and up to three meteorological towers. The Facility layout is illustrated in Figure 2. The energy generated at the Facility will deliver power to a single point of interconnection (POI) on the existing Fremont Center – Tiffin Center 138 kilovolt (kV) transmission line. The Facility will have an installed capacity of up to 198 megawatts (MW) and will deliver up to 640,000 megawatt-hours (MWh) of electrical power to the regional power grid. Construction is scheduled to begin in early 2020.

This analysis examines estimated impacts to the state and local economy generated from the construction and operation of the Facility. It includes a review of existing demographic and economic characteristics in the area, as well as several trends affecting both. When such comparison is informative, state and federal demographic and economic data are also included. Unless noted otherwise, the Study Area for this report includes the following 23 municipalities in Erie, Huron, Sandusky, and Seneca Counties; all of which are found wholly or partially within a 5-mile radius of the Facility (the Study Area):

- Village of Green Springs*
- Village of Republic
- City of Bellevue*
- City of Clyde
- City of Tiffin
- Adams Township
- Ballville Township
- Bloom Township
- Clinton Township
- Green Creek Township
- Groton Township
- Hopewell Township
- Jackson Township
- Liberty Township
- Lyme Township
- Norwich Township
- Pleasant Township
- Reed Township
- Scipio Township
- Sherman Township
- Thompson Township
- Townsend Township
- Venice Township
- York Township

*Note: The Village of Green Springs is geographically split between Sandusky and Seneca Counties. The City of Bellevue is geographically split between Erie, Huron, and Sandusky Counties

Part II of this report provides an examination of population trends within the State of Ohio and the Study Area, from 1990 through 2010, including projected population growth through 2030. In addition, Part II provides data regarding the civilian labor force for 2016 by state and county (latest data available). Part III reviews the types of potential impacts that could be experienced throughout the region, including those regarding housing demand, commercial and industrial employment, and transportation networks. Part IV describes the methods of analysis of potential economic benefits provided within this report, including an overview of the Job and Economic Development Impact (JEDI) Wind Model. This model was created by MRG & Associates, under contract with the National Renewable Energy Laboratory and is an industry standard for economic impact investigation. This is followed by the JEDI results (Part V), which describes the jobs created by the construction and operation of the Facility, as well as a summary of payments to landowners as a result of land leases for turbines. Part VI reviews potential impacts of the Facility from the perspective of local taxing jurisdictions. The findings of this report are summarized in Part VII, which is followed by a bibliography of cited sources in Part VIII.

Part II: Socioeconomic Profile

1. Population trends

Census data reveals that these communities have experienced a varied history of small population growth and decline over the past two decades. The 2015 population for the State of Ohio and Erie, Huron, Sandusky, and Seneca Counties is shown in Table 1 below. Ohio showed an increase in population between 2000 and 2015, however, the counties in the study area each experienced an overall decrease of equal or higher magnitude between the same duration. Huron County experienced the smallest annual rate of population decrease (-0.1%) while Erie and Seneca Counties experienced the greatest overall decrease in population, at an annual rate of 0.3%. As indicated in Table 2, many of the local municipalities also demonstrate a general decrease in population from 2000 to 2015. Notable exceptions include more urban settings, such as the Village of Green Springs, which experienced a population increase at an annual rate of 3.0% over the same time span. The City of Tiffin is the largest of the 23 municipalities within a 5-mile radius of the proposed turbines and has experienced only a small decline of growth (-0.1% annual rate) (Table 2).

Table 1: Population Trends

County	2000 Pop.	2010 Pop.	2015 Pop.	Annual Rate of Change (2000-2015)	Est. 2030 Pop.	% Change 2015-2030	2017 Population Density (people per square mile)
Erie County	79,551	77,079	76,141	-0.3%	72,942	-4.2%	297.5
Huron County	59,487	59,626	58,937	-0.1%	58,394	-0.9%	119.4
Sandusky County	61,792	60,944	60,187	-0.2%	58,642	-2.6%	146.6
Seneca County	58,683	56,745	55,929	-0.3%	53,361	-4.6%	101.1
State of Ohio	11,353,140	11,536,504	11,575,977	0.1%	11,805,281	2.0%	285.3

Source: U.S. Census Bureau, 2000 and 2010 Decennial Census and American Community Survey 5-Year Estimates 2011-2015. Population densities from American Community Survey 1- Year Estimates 2017. Projections derived from each jurisdiction's constant annual rate of change between 2000-2015.

For the purposes of this report, the trends experienced by each community from 2000 to 2015 are expected to continue regardless of whether the proposed Facility is built. Over the next decade, the total population within the Study Area is projected to increase by 1.3% from 2015 to 2025, from 70,791 to 71,702; mirroring the projected statewide increase of 1.4% during the same time span. Meanwhile, county population projections are expected to decline between the same time span. Seneca County is projected to experience the greatest decrease in population (-3.4%) from 2010-2025, while Huron County is projected to experience only a -0.7% decline in population during the same time span (see Table 1).

Table 2: Population Projections

Jurisdiction within 5-Miles Radius of Facility	2000 Pop.	2010 Pop.	2015 Pop.	Annual Rate of Change (2000-2015)	Est. 2030 Pop.	% Change 2015-2030	2016 Population Density (people per square mile)
City of Bellevue	8,193	8,282	8,109	-0.1%	8,026	-1.0%	1,335
City of Clyde	6,064	6,325	6,305	0.3%	6,560	4.0%	1,202.2
City of Tiffin	18,135	17,963	17,793	-0.1%	17,460	-1.9%	2,577.7
Adams Township	1,337	1,320	1,435	0.5%	1,544	7.6%	106.9
Ballville Township	6,395	5,985	5,911	-0.5%	5,479	-7.3%	175.1
Bloom Township	1,937	1,799	1,591	-1.2%	1,329	-16.4%	43.3
Clinton Township	4,188	4,109	4,052	-0.2%	3,922	-3.2%	130.6
Green Creek Township[1]	-	3,646	3,520	-0.7%	3,172	-9.9%	116.2
Groton Township	1,384	1,427	1,344	-0.2%	1,306	-2.9%	51.1
Hopewell Township	2,874	2,774	2,725	-0.3%	2,587	-5.1%	79.8
Jackson Township	1,609	1,608	1,702	0.4%	1,803	5.9%	48.0
Liberty Township	2,340	2,035	2,184	-0.4%	2,043	-6.5%	57.0
Lyme Township	968	853	690	-1.9%	516	-25.2%	35.6
Norwich Township	1,072	1,070	1,176	0.6%	1,295	10.2%	35.8
Pleasant Township	1,685	1,635	1,397	-1.1%	1,176	-15.8%	36.3
Reed Township	949	848	820	-0.9%	715	-12.8%	20.7
Scipio Township	1,831	1,729	1,704	-0.5%	1,590	-6.7%	47.2
Sherman Township	501	510	405	-1.3%	334	-17.5%	24.1
Thompson Township	1,422	1,443	1,446	0.1%	1,471	1.7%	37.2
Townsend Township	1,670	1,620	1,327	-1.4%	1,079	-18.7%	40.8
Venice Township	1,871	1,758	1,737	-0.5%	1,617	-6.9%	43.6
York Township	2,512	2,532	2,516	0.0%	2,520	0.2%	76.2
Village of Green Springs	599	738	902	3.4%	1,483	64.5%	1,567.2
Village of Republic	614	549	661	0.5%	713	7.9%	13.1
Total[2]	69,536	71,927	70,791	0.1%	72,079	1.8%	N/A

Source: U.S. Census Bureau, 2000 and 2010 Decennial Census and American Community Survey 5-Year Estimates 2011-2015. Projections derived from each jurisdiction's constant annual rate of change between 2000-2015. Population densities from American Community Survey 1-Year Estimates 2016.

[1] Denotes that entity did not exist as currently structured as of April 1, 2010, Census Day, % change is calculated from 2010-2015
[2] Totals calculated by formula, may reflect rounding errors

Although construction employment related to the construction of the Facility will be substantial, this employment is relatively short term and is not expected to result in the permanent relocation of construction workers to the area; therefore, the Facility is not anticipated to generate significant population growth within the Study Area. The number of potential short- and long-term employment opportunities associated with the construction and operation of the Facility is discussed in further detail below.

2. Employment statistics

Table 3 illustrates the size of the local labor force in counties located either wholly or partially within 5 miles of the proposed Facility, as well as the broader State of Ohio. The total annual unemployment rate for Sandusky and Seneca Counties has been relatively consistent with that of the state over the last two years; however, the total annual unemployment rate for Erie and Huron Counties has been slightly higher compared to that of the state. Annual average unemployment rates have decreased both statewide and countywide from 2014 to 2016. Table 4a through Table 4e illustrates employment figures in the State of Ohio and Erie, Huron, Sandusky, and Seneca Counties broken down by sector for 2015.

Table 3: Local Labor Force and Unemployment

Place	Labor Force	Employed	Unemployed	Unemployment rate	Unemployment rate, 2015 (annual)	Unemployment rate, 2014 (annual)
Erie County	37,127	35,100	2,027	5.5%	5.5%	6.4%
Huron County	27,864	26,063	1,801	6.5%	6.6%	8.0%
Sandusky County	30,908	29,465	1,443	4.7%	4.8%	5.7%
Seneca County	27,164	25,855	1,309	4.8%	4.8%	5.7%
State of Ohio	5,713,088	5,430,790	282,298	4.9%	4.9%	5.8%

Note: Not Seasonally Adjusted; Source: U.S. Bureau of Labor Statistics, 2016.

Table 4a: Employment and Payroll by NAICS Sector in the State of Ohio

NAICS code description	Paid employees for pay period including March 12, 2015	First-quarter payroll ($1,000)	Annual payroll ($1,000)	Total establishments
Total for all sectors	4,719,985	52,632,423	213,161,303	251,668
Agriculture, forestry, fishing and hunting	1,204	8,631	39,876	269
Mining, quarrying, and oil and gas extraction	12,932	209,203	782,917	743
Utilities	23,839	772,796	2,334,102	667
Construction	179,883	2,139,534	10,690,205	19,731
Manufacturing	663,884	9,079,228	36,324,428	14,139
Wholesale trade	235,573	3,588,415	14,334,142	14,035
Retail trade	565,140	3,521,203	14,591,663	36,339
Transportation and warehousing	171,286	1,902,972	8,103,911	7,448
Information	84,415	1,472,345	5,770,568	3,752
Finance and insurance	241,764	5,486,773	18,452,171	17,247
Real estate and rental and leasing	65,324	839,757	3,144,738	10,075
Professional, scientific, and technical services	250,042	3,924,804	16,715,335	24,087
Management of companies and enterprises	150,099	4,165,339	15,062,999	2,186
Administrative and support and waste management and remediation services	397,326	2,874,844	12,629,484	13,526
Educational services	120,934	820,867	3,369,061	3,089
Health care and social assistance	824,772	8,466,783	35,979,928	28,976
Arts, entertainment, and recreation	67,047	480,459	2,442,370	3,766
Accommodation and food services	461,895	1,580,929	6,927,919	23,697
Other services (except public administration)	202,085	1,295,507	5,456,190	27,493
Industries not classified	541	2,034	9,296	403

Source: U.S. Census Bureau, 2015

Table 4b: Employment and Payroll by NAICS Sector in Erie County

NAICS code description	Paid employees for pay period including March 12, 2015	First-quarter payroll ($1,000)	Annual payroll ($1,000)	Total establishments
Total for all sectors	30,596	261,881	1,152,632	1,854
Agriculture, forestry, fishing and hunting	a	D	D	3
Mining, quarrying, and oil and gas extraction	115	522	2,867	5
Utilities	b	D	D	5
Construction	782	8,596	46,306	130
Manufacturing	6,718	81,201	334,553	97
Wholesale trade	1,151	12,840	57,368	67
Retail trade	4,683	24,899	108,351	306
Transportation and warehousing	618	5,963	28,668	44
Information	466	3,877	15,919	20
Finance and insurance	624	9,876	36,739	111
Real estate and rental and leasing	272	2,186	9,774	70
Professional, scientific, and technical services	623	8,602	35,667	112
Management of companies and enterprises	198	2,816	10,935	13
Administrative and support and waste management and remediation services	611	4,248	21,754	80
Educational services	356	2,029	8,349	25
Health care and social assistance	4,886	46,861	201,401	221
Arts, entertainment, and recreation	1,272	20,713	106,854	71
Accommodation and food services	6,017	19,665	97,837	267
Other services (except public administration)	1,134	5,377	23,546	204
Industries not classified	7	19	24	3

a: 0-19 employees
b: 20-99 employees
D: Withheld to avoid disclosing data for individual companies; data are included in higher level totals.
Source: U.S. Census Bureau, 2015

Table 4c: Employment and Payroll by NAICS Sector in Huron County

NAICS code description	Paid employees for pay period including March 12, 2015	First-quarter payroll ($1,000)	Annual payroll ($1,000)	Total establishments
Total for all sectors	16,689	145,737	668,873	1,132
Agriculture, forestry, fishing and hunting	a	D	D	2
Mining, quarrying, and oil and gas extraction	-	-	-	-
Utilities	b	D	D	3
Construction	1135	13530	96336	128
Manufacturing	4895	53,647	231,826	86
Wholesale trade	631	6,764	30,745	49
Retail trade	2,157	12,227	52,130	174
Transportation and warehousing	798	8,651	39,183	38
Information	135	1,607	6,731	17
Finance and insurance	428	4,878	18,711	72
Real estate and rental and leasing	143	965	4,127	43
Professional, scientific, and technical services	406	3,306	13,984	80
Management of companies and enterprises	b	D	D	2
Administrative and support and waste management and remediation services	371	1,749	8,354	39
Educational services	85	330	1,455	10
Health care and social assistance	2743	27,162	115,889	98
Arts, entertainment, and recreation	110	717	3,590	16
Accommodation and food services	1,555	4,036	18,370	111
Other services (except public administration)	986	4,750	20,282	163
Industries not classified	a	D	D	1

a: 0-19 employees
b: 20-99 employees
D: Withheld to avoid disclosing data for individual companies; data are included in higher level totals.
Source: U.S. Census Bureau, 2015

Table 4d: Employment and Payroll by NAICS Sector in Sandusky County

NAICS code description	Paid employees for pay period including March 12, 2015	First-quarter payroll ($1,000)	Annual payroll ($1,000)	Total establishments
Total for all sectors	23,195	199,723	848,385	1,321
Agriculture, forestry, fishing and hunting	4	36	736	4
Mining, quarrying, and oil and gas extraction	c	D	D	3
Utilities	43	1021	3752	4
Construction	951	8,820	50,951	145
Manufacturing	9,031	98,612	406,383	106
Wholesale trade	699	7,696	31,861	53
Retail trade	2,491	14,558	60,862	197
Transportation and warehousing	915	9,831	42,732	56
Information	144	1,266	5,497	12
Finance and insurance	488	5,581	21,429	79
Real estate and rental and leasing	166	1,063	4,345	37
Professional, scientific, and technical services	404	3,612	15,089	77
Management of companies and enterprises	129	2,197	10,360	5
Administrative and support and waste management and remediation services	736	5,645	23,072	60
Educational services	65	267	1,136	9
Health care and social assistance	3,467	25,906	108,764	176
Arts, entertainment, and recreation	254	887	4,726	24
Accommodation and food services	1,983	5,105	23,744	120
Other services (except public administration)	1,049	4,924	20,948	153
Industries not classified	a	D	D	1

a: 0-19 employees
c: 100-249 employees
D: Withheld to avoid disclosing data for individual companies; data are included in higher level totals.
Source: U.S. Census Bureau, 2015

Table 4e: Employment and Payroll by NAICS Sector in Seneca County

NAICS code description	Paid employees for pay period including March 12, 2015	First-quarter payroll ($1,000)	Annual payroll ($1,000)	Total establishments
Total for all sectors	17,109	135,030	571,777	1,128
Agriculture, forestry, fishing and hunting	b	D	D	2
Mining, quarrying, and oil and gas extraction	59	569	3,000	5
Utilities	101	2153	7699	7
Construction	849	7,914	42,559	117
Manufacturing	4,208	49,430	197,917	72
Wholesale trade	821	9,326	39,169	52
Retail trade	2,315	14,305	57,401	168
Transportation and warehousing	559	5,088	22,629	51
Information	137	1,095	4,228	13
Finance and insurance	409	5,251	20,931	66
Real estate and rental and leasing	79	516	2,306	27
Professional, scientific, and technical services	385	2,803	11,889	66
Management of companies and enterprises	81	1,410	6,814	7
Administrative and support and waste management and remediation services	325	2,180	11,018	39
Educational services	1697	9,624	40,030	11
Health care and social assistance	2,680	15,755	69,789	137
Arts, entertainment, and recreation	187	403	2,194	16
Accommodation and food services	1,389	3,546	16,009	106
Other services (except public administration)	805	3,447	15,121	163
Industries not classified	2	16	69	3

b: 20-99 employees
D: Withheld to avoid disclosing data for individual companies; data are included in higher level totals.
Source: U.S. Census Bureau, 2015

Part III: Regional Development Impacts

The regional economy surrounding the Study Area is shaped in large part by the agricultural industries of Erie, Huron, Sandusky, and Seneca Counties. While the Study Area is predominantly rural, the City of Toledo (west of the Study Area) and the City of Cleveland (east of the Study Area), both significant metropolitan regions, are each in relative proximity to the Study Area. Erie, Huron, Sandusky, and Seneca Counties are primarily agricultural in nature. The regional context for the development of this Facility is discussed in further detail below, concentrating on three primary components: housing, commercial and industrial development, and transportation. In addition, the compatibility of the proposed Facility with regional developmental goals and plans is reviewed.

1. Housing

As with all sectors of the economy, the housing market throughout the region has felt the impact of population loss. Owner-occupied vacancy rates in Erie, Huron, Sandusky, and Seneca Counties (ranging from 2.0% to 2.3%) are slightly higher than the statewide average of 1.9%. The rental vacancy rate in Huron County (11.7%), Sandusky County (9.7%), and Seneca County (7.1%) is substantially higher than the statewide average of 6.5%, while the rental vacancy rate in Erie County is only 0.1% higher than the statewide average.

Erie, Huron, Sandusky, and Seneca Counties feature a median monthly gross rent level of $707, $630, $634, $645, respectively, all of which is below the statewide average of $730/month. Each county has a lower than statewide percentage of households whose rent accounts for more than 35% of their household income. In addition, the median housing values of Huron, Sandusky, and Seneca Counties are below the statewide average of $129,900, while Erie County's median housing value ($131,400) is slightly above the statewide average.

It is estimated that 13,631 housing units within Erie, Huron, Sandusky, and Seneca Counties are currently vacant. Given these figures, in addition to the population projections discussed in Part II of this report, it is not expected that the development of the Facility will have a significant impact on the regional housing market. While the Facility development may not represent a widespread boom for rental property owners, it is worth noting that the availability of vacant rental housing also indicates that the Facility should not have a destabilizing effect on current renters.

Table 5: Study Area Housing Characteristics

Municipality/County/State	Total housing units	Occupied units	Vacant units	Vacancy rate		Median housing value of owner-occupied units	Median gross rent (monthly)	% of households with gross rent > 35% of household income
				Home - owner	Rental			
Village of Green Springs	265	256	9	0.0%	0.0%	$82,700	$835	52.9%
Village of Republic	2757	257	18	3.3%	0.0%	$78,000	$736	23.7%
City of Bellevue	3,648	3,220	428	3.2%	14.3%	$96,000	$637	22.2%
City of Clyde	2,806	2,484	322	5.4%	4.6%	$94,900	$630	42.2%
City of Tiffin	7,403	6,593	810	1.6%	9.1%	$91,600	$657	36.4%
Adams Township	585	529	56	0.0%	0.0%	$131,300	$647	10.8%
Ballville Township	2,898	2,638	260	1.6%	16.8%	$143,500	$683	31.9%
Bloom Township	664	630	34	0.0%	9.5%	$84,800	$539	38.0%
Clinton Township	1,912	1,812	100	2.2%	3.9%	$135,400	$639	34.1%
Green Creek Township	1,478	1,427	51	0.0%	0.0%	$97,100	$650	6.9%
Groton Township	*570*	*553*	*17*	*0.0%*	*0.0%*	*$145,700*	*(x)*	*0.0%*
Hopewell Township	1,167	1,017	150	0.0%	0.0%	$114,800	$752	19.0%
Jackson Township	651	596	55	0.9%	0.0%	$126,500	$621	48.1%
Liberty Township	925	863	62	2.6%	0.0%	$83,700	$659	48.2%
Lyme Township	296	288	8	0.0%	0.0%	$153,500	(x)	0.0%
Norwich Township	439	414	25	0.0%	22.7%	$126,300	$821	89.9%
Pleasant Township	622	547	75	3.4%	0.0%	$125,000	$784	7.0%
Reed Township	346	310	36	0.0%	0.0%	$95,000	$1,043	15.9%
Scipio Township	769	702	67	1.0%	0.0%	$123,000	$715	34.5%
Sherman Township	182	167	15	0.0%	0.0%	$138,300	(x)	0.0%
Thompson Township	522	455	67	7.3%	0.0%	$131,800	(x)	(x)
Townsend Township	713	480	233	12.6%	21.8%	$125,700	$639	0.0%
Venice Township	857	697	160	7.5%	13.3%	$88,300	$700	25.8%
York Township	1,013	951	62	0.0%	0.0%	$138,400	$695	31.7%
Erie County	37,739	31,767	5,972	2.1%	6.4%	$131,400	$707	32.8%
Huron County	*25,134*	*22,527*	*2,607*	*2.0%*	*11.7%*	*$116,100*	*$630*	*33.4%*
Sandusky County	26,257	23,626	2,631	2.3%	9.7%	$110,100	$634	39.4%
Seneca County	23,959	21,538	2,421	2.1%	7.1%	$96,900	$645	36.3%
Ohio Statewide	5,140,902	4,585,084	555,818	1.9%	6.5%	$129,900	$730	40.3%

Source: U.S. Census Bureau, American Community Survey 5-Year Estimates 2011-2015. (x) = data unavailable

2. Commercial and Industrial Development

The diversification of Ohio's energy portfolio will have significant and positive economic impacts beyond a reduced dependence on coal imported from outside of the state. The Environment Ohio Research & Policy Center estimated that if the State of Ohio increased wind power production to 20% of the state's total energy portfolio by 2020, such development would create 3,100 permanent, full-time positions within the state, and result in cumulative wages totaling $3.7 billion. This same analysis estimated that such a commitment would result in an increase in gross state product of approximately $8.2 billion by 2020 (Environment Ohio, 2007).

These impacts are principally due to the impact of wind energy development on the manufacturing sector. The State of Ohio is uniquely positioned to take advantage of advanced manufacturing opportunities for the development and distribution of wind power technology, according to the Renewable Energy Policy Project's (2004) report, "Wind Turbine Development: Location of Manufacturing Activity." This analysis estimates that if the United States were to invest $50 billion into 50,000 MW of new wind power production, Ohio manufacturers could stand to create 11,688 jobs in wind turbine and related manufacturing, accounting for 1.95% of the total investment; by way of comparison, the American Wind Energy Association estimates that the State of Ohio alone has enough wind resources to generate nearly 359 MW at 80m hub height and 110,439 MW at 110m hub height of onshore wind energy (AWEA, 2015).

The Environmental Law & Policy Center estimated that the State of Ohio is currently home to 106 wind power supply chain businesses, providing 1,000 to 2,000 jobs throughout the state (ELPC, 2011). Wind energy technology manufacturing opportunities include rotors, controls, drive trains, generators, and towers. Several of these manufacturers and other wind power-related businesses are located in the Greater Cleveland Region (AWEA, 2015).

Specific short- and long-term economic impacts of this Facility on commercial and industrial development throughout the region are described in further detail in Part V of this report.

3. Transportation

The region surrounding the Facility features numerous Interstates, U.S, and State highways, as well as county and local roadway networks, in addition to freight rail lines and small airports. These facilities are described in further detail below. The main transportation route to the Facility is I-80/90 (Ohio Turnpike), which runs just north of the 5-mile Study Area. U.S. Route 20 (north) and State Route 4 (east) run adjacent to the Facility. State Routes 53 and 269 provide direct access into the Facility. These and other primary routes facilitate transportation between the Facility and the surrounding metropolitan areas.

Workers coming to and from the site will most likely enter via State Route 4 or 20 from I-80/90. Construction traffic bound for the substations will likely use State Route 53 as the primary route, while traffic bound for the Operations and Maintenance area will most likely use U.S. Route 20 as the primary route. The proposed Facility is not expected to cause any substantial disruption to major transportation corridors serving the Study Area.

Freight rail lines connect several of the municipalities throughout the Study Area. CSX and Norfolk Southern operate the majority of Ohio's freight rail system, although smaller operators such as Ashland Railway, Northern Ohio and Western Railway, and Wheeling and Lake Erie Railway also operate in the area. Study Area municipalities connected to freight rail lines include the Cities of Bellevue, Clyde, and Tiffin, the Townships of Adams, Ballville, Bloom, Clinton, Green Creek, Groton, Hopewell, Jackson, Liberty, Lyme, Norwich, Pleasant, Reed, Scipio, Thompson, Venice, and York, and the Village of Green Springs. The rail system may be used for the transportation of a very small number of turbine component and equipment suppliers, but the Applicant does not anticipate making any modifications to the system.

The Study Area is also in proximity to the Huron County Airport, the Sandusky County Regional Airport, the Seneca County Airport, the Bandit Field Airport, the Fremont Airport, the Fostoria Airport, the Weiker Airport, and the Willard Airport. Construction and operation of the Facility will be designed according to Federal Aviation Administration (FAA) standards and are not expected to result in any adverse impacts to the regional air transportation network. The Applicant will file a notice of proposed construction or alteration (Form 7460-1) with the FAA to confirm the structure will not result in a substantial adverse impact.

4. Local and Regional Plan Compatibility

Several of the municipalities within the five-mile study area have adopted comprehensive land use plans, strategic downtown plans, and/or economic development plans. Each of these are summarized below:

- <u>City of Bellevue Vision 2025 Comprehensive Master Plan</u>: This plan, adopted in 2005 by the Bellevue City Council, identifies the need for a 20-year vision, in which the issues, concerns, goals, and priorities of the community are addressed through civic engagement. High-paying job creation in the manufacturing sector, as well as the retention of existing jobs and the preservation of existing farming operations are goals and issues presented in the plan (City of Bellevue, 2005). In terms of economic development, the Facility offers an opportunity for the use of local goods and services, including but not limited to labor, equipment, and maintenance. In addition, the payments associated with land leases provide additional income for landowners, including agricultural producers, and in doing so, improves the economic conditions for existing farming practices.

- 2016 City of Tiffin Downtown Strategic Growth and Development Plan: This strategic plan complements the previously-created 2010 Strategic Downtown Tiffin Plan, which "creates urban design solutions with policy recommendations to invigorate the urban core and community as a whole, with a revitalized and enhanced downtown" (City of Tiffin, 2010). Guided by revitalization principles for downtown areas and the local economy, the plan recommends that infill development utilize alternative energy when possible and support opportunities to develop local green tech industries (City of Tiffin, 2016). While the Facility does not directly impact the downtown area, it is compatible with the strategic plan through its diversification of the region's energy resource portfolio, adding resilience and reliability to the supply of energy resources to local businesses. The Facility also offers an opportunity for the use of local goods and services, including those provided by businesses located in the downtown area.

- 1995 Erie County Comprehensive Development Plan: This plan "determines the immediate and future needs of the community and provides ways to allow the County to guide appropriate land uses to the most suited areas for that kind of development" (Erie County, 1995). By analyzing the existing conditions and growth trends of the County, along with issues facing the region, the plan identifies goals for future land use and policy making. The Facility is compatible with the Plan's goal to "promote community development through the improvement of infrastructure that meets development demands".

- 2017 Huron County Comprehensive Land Use Plan: Originally developed in 2007 and last revised in 2017, the Huron County Commissioners, the Huron County Comprehensive plan aims to manage future growth within the County to cohesively guide development patterns over the next thirty years. A key goal is to promote Huron County as a development destination and to retain and expand existing businesses (Huron County, 2017). The Facility is compatible with this goal due to the positive impacts it will create for the local economy.

- 2013 Sandusky County Comprehensive Plan: This plan is an update to the 2003 Comprehensive Plan and is intended to be long-range plan used to guide growth and development using current existing condition, along with updated trends and priority project. A major goal of the plan is to facilitate the economic health and growth of the County and its municipalities by expanding on the tax and employment base. Furthermore, the plan "promotes and facilitates the proper placement and provision of energy infrastructure components throughout the County, including but not limited to wind farms and solar arrays" (Sandusky County, 2013). The Facility is compatible with these goals, specifically the placement and provision of alternative energy infrastructure.

- 2011 Seneca County Comprehensive Economic Development Strategy: The plan is intended to position Seneca County as a "redevelopment area," as defined by the EDA, and thus to make its political subdivisions eligible to apply from the EDA Public Works and other programs. As specified by the plan, "the assumptions, goals, and strategies laid out in the plan create a blueprint for the County's overall economic development and a summary of what is considered the most effective and proactive, targeted strategy to improve the economic position and climate of Seneca County" (Seneca County, 2011). The plan also specifies that the County recently approved a resolution to make Seneca County an "Alternative Energy Zone", making it eligible for state tax incentives. The Facility is compatible with the plan's priority action to improve the local economy and implement alternative energy.

The Facility is located in an area that is largely rural in nature with a majority of impacts from the Facility construction and operation occurring on land used for agriculture. The economic benefits of the turbines for local agriculturalists, as well as their overall compatibility with farming practices, will support and aid in the preservation of local farming operations. Furthermore, the jobs and economic development created by Facility may help to create and retain existing local employment opportunities. Therefore, the development of this Facility is compatible with the goals and strategies of existing local and regional plans.

5. Concurrent or secondary uses

Facility components will be located on portions of leased land with existing rural residential or agricultural uses. These existing uses are expected to continue throughout the lifetime of the Facility.

Part IV: Assessing Job and Economic Development Impacts

1. Jobs and Economic Development Impact (JEDI) Model

The proposed Republic Wind Farm is anticipated to have local and statewide economic benefits. Wind power development, like other commercial development projects, can expand the local, regional, and statewide economies through both direct and indirect means. Income generated from direct employment during the construction and operation phases of the wind farm is used to purchase local goods and services, creating a ripple effect throughout the state. The Job and Economic Development Impact (JEDI) Wind model allows users to estimate exactly that; the jobs and the economic development impacts from wind power generation projects for both the construction and operation phases of the proposed Facility (NREL 2017). These economic development impacts, categorized by the levels of impact and indicators described below, include onsite jobs and earnings, economic output from these onsite earnings, local revenue/supply chain jobs and earnings, economic output from these local revenue/supply chain earnings, induced jobs and earnings, and economic output from these induced jobs and earnings. The JEDI model was created by the National Renewable Energy Laboratory (NREL), a national laboratory of the United States Department of Energy. It then calculates the aforementioned indicators for each level of impact using project-specific data provided by the Applicant and geographically-defined multipliers. These multipliers are produced by IMPLAN Group, LLC using a software/database system called IMPLAN (IMpact analysis for PLANing), a widely-used and widely-accepted general input-output modeling software and data system that tracks unique industry groups in various levels of the regional data (IMPLAN Group, 2018).

Using the JEDI wind model, this report analyzes three levels of impact that the proposed Facility may have on the economy:

> **On-site labor impacts:** These are the direct impacts experienced by the companies/individuals residing in the State of Ohio engaged in the onsite construction and operation of the Facility. These values represent expenditure of dollars on labor (wages, salaries and associated expenses) by Facility onsite construction personnel as well as operation and maintenance (O&M) personnel. On-site labor impacts do not reflect material expenditures. Most other input-output models consider this level as "direct impacts", referring to changes in jobs, economic activity and earnings associated with the immediate impacts created by the investment, which would include the equipment installed onsite, the concrete used onsite, etc. However, the immediate economic impacts of the physical items used onsite, normally included in direct impacts, typically occur at some geographic distance from the project itself. Because of JEDI's focus on the local impacts of a Facility, only the labor associated with the on-site location of the Facility (Construction and Construction-Related Services) is counted at this level.

Local revenue and supply chain impacts: These impacts measure the estimated increase in demand for goods and services in industry sectors that supply or otherwise support the companies engaged in construction and operation (also known as "backward-linked" industries). These measures account for the demand for goods and services such as turbine components, project analysis, legal services, financing, insurance, etc. Most other input-output models consider this level as "indirect impacts", referring to economic impacts associated with linked sectors in the economy that are upstream of the direct impacts, such as suppliers of hardware used to make the equipment installed onsite or the concrete used onsite. However, because of JEDI's focus on the local impacts of the Facility, labor for components of this Facility (e.g. turbine manufacturers) occurring at off-site locations is also counted in this level as a local revenue and supply chain impact.

Induced Impacts: Induced impacts measure the estimated effect of increased household income resulting from the project. Induced impacts reflect the reinvestment of earned wages, as measured throughout the first two levels of economic impact. This reinvestment can occur anywhere within the local, regional, or state economy, on household goods, entertainment, food, clothing, transportation, etc.

Each of these three levels of impact can be measured in terms of three indicators: jobs (as expressed through the increase in employment demand), the amount of money earned through those jobs, and the overall economic output associated with each level of economic impact. These indicators are described in further detail:

Jobs: Jobs refer to the increase in employment demand because of facility development. These positions are measured across each level of impact, so that they capture the estimated number of jobs on site, in supporting industries, and in the businesses, that benefit from household spending. For the purposes of this analysis, this term refers to the total number of year-long full-time equivalent (FTE) positions created by the Facility. Persons employed for less than full time or less than a full year are included in this total, each representing a fraction of a FTE position (e.g. a half-time, year-round position is 0.5 FTE).

Earnings: This measures the wages and salary compensation paid to the employees described above.

Output: Output refers to the value of industry production in the state economy, across all appropriate sectors, associated with each level of impact. For the manufacturing sector, output is calculated by total sales plus or minus changes in inventory. For the retail sector, output is equal to gross profit margin. For the service sector, it is equal to sales volume. For example, output would include the profits incurred by those businesses that sell electrical transmission line, concrete, or motor vehicle fuel to the Applicant.

2. Methodology

Calculating the number of jobs and economic output from a proposed facility using the JEDI model is a two-step process. The first step requires a limited amount of facility-specific data inputs (such as year of construction, size of Facility, turbine size and location). For the analysis, the following data were used as facility-specific modeling inputs.

- Location: Ohio
- Year of Construction: 2020
- Total Project Nameplate Capacity: 200 MW
- Number of Turbines: 47
- Average Turbine Capacity: 4.255 MW
- Money Value (Dollar Year): 2018

Note that the Applicant presents a turbine layout of up to 50 turbines for permitting purposes, each with a nameplate capacity rating of 4.2 to 4.5 megawatts (MW). However, the total generating capacity of the Facility will not exceed 200 MW. Therefore, the number of turbines to be constructed will range between 44 and 47, depending on the model of turbine selected. Since no more than 47 turbines will ultimately be constructed, this socioeconomic report analyzes the total number of positive jobs and economic impacts produced by a 47 turbine Facility rather than a 50 turbine Facility, to avoid overestimating the Facility's economic benefits.

Using this Facility-specific data, the JEDI model then creates a list of default values, which includes project cost values, default financial parameter values, default tax values, default lease payment values, and default local share of spending values. These default values are derived from 10 years of research by NREL, and stem from various sources, including interviews and surveys from leading project owners, developers, engineering and design firms, and construction firms active in the wind energy sector. The version of the model (W9.14.18) used for the job and economic impact analysis presented here used the most currently available (2016) multiplier data specific to Ohio to estimate potential impacts on a statewide basis. The second step of the JEDI model methodology requires the review, and if warranted, the customization of default project cost values and financial parameter values to more reasonable estimates. The Applicant reviewed the default project cost values subtotaled by each of the following categories in the JEDI model: Equipment during Construction, Balance of Plant Construction, Labor during Operation & Maintenance, Materials and Services during Operation & Maintenance, Financial Parameters, Tax Parameters, Land Lease Parameters and Payroll Parameters. The Applicant reviewed the default values in November 2018 and determined whether they were appropriate for the project under review. As a result of that review, adjustments were made to specific default values (see Table 6). The remaining JEDI default values were reviewed and determined to be reasonable estimates based on the Applicant's previous experience in wind energy development.

Table 6: Adjustments Made to Default JEDI Model Costs

JEDI Cost Items (Annual Estimates)	Default Value	Adjusted Value	Change
Construction Equipment Costs	$241,413,521	$[redacted]	[redacted]
Construction Materials Costs	$50,587,878	$[redacted]	[redacted]
Construction Labor Total Costs	$20,956,908	$[redacted]	[redacted]
Development Costs	$9,004,072	$[redacted]	[redacted]
Sales Tax for Construction Materials and Equipment	$15,304,784	$[redacted]	[redacted]
Equity Financing Repayment Term	10 years	$[redacted]	[redacted]
Taxes Per MW	$0	$[redacted]	[redacted]
Land Lease (Total Cost)	$600,000	$[redacted]	[redacted]

Part V: Job and Economic Development Impacts on the Statewide Economy

An economic impact analysis was performed for the Republic Wind Farm (the Facility) to be constructed in 2020 with a rated capacity of 200 MW and an assumed 47 turbines, sized at 4.255 MW. The analysis presented here used the most currently available (2016) multiplier data specific to Ohio to estimate potential impacts on a statewide basis. The results of this analysis, estimated for both the construction and operation phases of the proposed Facility, are illustrated in Table 7 and summarized in the narrative that follows.

Table 7: Summary Results of Job and Economic Impact Analysis

	Jobs	Earnings (Millions)	Output (Millions)
Construction			
Project Development and Onsite Labor Total	181	$10.5	$10.6
Construction & Interconnection Labor	180	$10.3	-
Construction Related Services	1	$0.1	-
Turbine & Supply Chain Impacts	403	$22.7	$75.7
Induced Impacts	169	$8.3	$25.9
Total Impacts	**753**	**$41.4**	**$112.2**
Annual Operation			
Onsite Labor Impacts	10	$0.6	$0.6
Local Revenue and Supply Chain Impacts	22	$1.2	$3.8
Induced Impacts	9	$0.5	$1.5
Total Impacts	**41**	**$2.3**	**$5.9**

Source: NREL JEDI Model (version W9.14.18) (USDOE NREL, 2018)
Notes: Earnings and Output values are millions of dollars in 2018 dollars. Totals may not add up due to independent rounding. Results are based on model default values.

Demand for new jobs associated with the Facility will be created during both the initial construction period and the years following construction, in which the Facility is in operation. The money injected into the statewide economy through the creation of these jobs will have long-term, positive impacts on individuals and businesses in Ohio as it ripples through the economy.

1. Statewide Job and Economic Development Impact: Construction

Based upon JEDI model computations, it is anticipated that construction of the proposed Facility will directly generate employment of an estimated 181 FTE on-site construction and project development positions for Ohio residents, which will be for Construction and Interconnection Labor and Construction Related Services. The JEDI model estimates in a total of $10.3 million for annual earnings of the 180 on-site construction jobs. Turbine manufacturing and supply chain industries could in turn generate an additional 403 jobs across the State of Ohio over the course of Facility construction. In addition, Facility construction could induce demand for 169 jobs statewide through the spending of additional household income. Based on the results of the model, the total impact of potentially 753 new jobs could result in up to $41.4 million of earnings, assuming a 2018 construction schedule and wage rates consistent with statewide averages. Facility construction labor wages for similar construction positions within the North Northeastern Ohio Non-Metropolitan Area (which includes Seneca and Sandusky Counties) range from an average of $18.18 per hour for Construction Laborers, $24.09 for Electricians, and $50.14 for Construction Managers (Bureau of Labor Statistics, 2016). Local, regional, and statewide employment during the construction phase will primarily benefit those in the construction trades, including equipment operators, truck drivers, laborers, and electricians. Facility construction will also require workers with specialized skills, such as crane operators, turbine assemblers, specialized excavators, and high voltage electrical workers. It is anticipated that many of the highly-specialized workers will come from outside the area and will remain only for the duration of construction.

In addition to jobs and earnings, the construction of the Facility is expected to have a positive impact on statewide economic output, a measurement of the value of goods and services produced and sold by backward-linked industries. As described in the definition above, output provides a general measurement of the amount of profit earned by manufacturers, retailers, and service providers connected to a given project. Based on the results of the model, the value of economic output associated with Facility construction is estimated to be $112.2 million. Between workers' additional household income and industries' increased production, the impacts associated with the Facility are likely to be experienced throughout many different sectors of the statewide economy. Pursuant to Section 5727.75 of the Ohio Revised Code (ORC), the Facility may qualify for tax incentives based on the degree to which it employs in-state construction labor (see Part VI). At the time of the publication of this report, it is not yet known what portion of construction labor will be Ohio-domiciled.

2. Statewide Job and Economic Development Impact: Operations and Management

Based upon JEDI model computations, the operation and maintenance of the proposed Facility is estimated to generate 10 full-time equivalent onsite jobs with combined estimated annual earnings of approximately $0.6 million. These 10 jobs are anticipated to be comprised of Project Management, Technician, and Administrative personnel. Projected wage rates are projected to be consistent with statewide averages which are estimated to be $17.32 per hour for Payroll and Timekeeping Clerks, $21.78 per hour for Mechanical Engineering Technicians, and, $45.66 for General and Operations Managers (Bureau of Labor Statistics, 2016). These 10 full-time local jobs generated by the wind energy facility comprise the Facility's direct long-term employment impact.

Operations and maintenance should also generate new jobs in other sectors of the economy through supply chain impacts and the expenditure of new and/or increased household earnings. Increased employment demand throughout the supply chain is estimated to result in approximately 22 jobs with annual earnings of approximately $1.2 million. In addition, it is estimated that 9 jobs with associated annual earnings of $0.5 million will be induced through the increased household spending associated with Facility operations. In total, while in operation, this Facility is estimated to generate demand for 41 jobs per year with annual earnings of approximately $2.3 million. Total economic output could also increase by an estimated $5.9 million as a result of Facility operations and maintenance.

3. Land Lease Payments

Operation of the Project will result in payment to local landowners in association with the lease agreements executed to host Project components. These annual lease and easement payments will offer direct benefits to participating landowners, which will be in addition to any income generated from the surrounding land use (e.g. agricultural production). The Applicant estimates that these payments will total approximately $1,300,000 million on an annual basis each year the Project is in operation, although this value is contingent upon project details still in development (e.g., turbine choice and layout). The Project will also generate lease payments during the construction phase; while the value is currently unknown, the lease payments will have a beneficial impact on the local economy during construction. These lease payments will have a positive impact on the region, to the extent that landowners will spend their revenue locally.

Part VI: Local Tax Revenues

1. Legislative Context

Wind energy projects in the State of Ohio can be exempted from tangible personal property and real property tax payments if they meet certain conditions. These conditions are enumerated in Section 5727.75 of the ORC. Operators of these exempted projects, known as qualified energy projects (QEP), are instead required to make annual payments in lieu of taxes (PILOT). In order to be certified as a QEP by the state, a project must meet all of the following criteria:

- an application for certification of the energy project as a QEP that complies with the requirements under Section 5727.75 of the ORC and Chapter 122:23-1 of the OAC must be submitted to the director of the Ohio Development Services Agency (ODSA) on or before December 31, 2020;
- an application under Section 4906.20 of the ORC must be submitted to the Ohio Power Siting Board (OPSB) on or before December 31, 2020;
- the county commissioners of a county in which property of the project is located must have adopted a resolution approving the application submitted to ODSA or the county commissioners must pass a resolution declaring the county an alternative energy zone (AEZ);
- at least 50% of the full-time equivalent construction and installation employees, as defined in Section 5727.75 of the ORC, must be Ohio-domiciled; and
- construction (defined as either the date the application for a certificate is filed with OPSB or the date the contract for construction or installation is entered into, whichever is earlier) must begin by January 1, 2021.

If an applicant is granted exemption from taxation for any of the tax years 2011 through 2021, the QEP will be exempt from taxation for tax year 2022 and all ensuing years if the property was placed into service before January 1, 2022. The amount of PILOT to be paid annually to the county treasurer, ranging from $6,000 and $8,000, is assessed per megawatt (MW) of nameplate capacity, with the rate dependent on the percentage of construction/installation employees who are domiciled in Ohio. The PILOT would be: $6,000 per MW, if during construction the project employs 75% or more Ohio-domiciled employees; $7,000 per MW, if during construction the project employs 60% or more Ohio-domiciled employees; and $8,000 per MW, if during construction the project employs the minimum requirement of 50% or more Ohio-domiciled employees (Table 8). County commissioners may require an additional service payment, as long as the total of the additional payment and the PILOT do not exceed $9,000 per MW.

Table 8: Service Payment per Megawatt Schedule

Annual Service Payment per Megawatt of Nameplate Capacity	Ratio of Ohio-Domiciled Full-Time Equivalent Employees
$6,000	75% or More
$7,000	60% to 74%
$8,000	50% to 59%

2. Estimated Payments In Lieu Of Taxes

Turbines for the Republic Wind Farm are anticipated to be located in a total of five municipalities (Adams, Pleasant, Reed, Scipio, and Thompson Townships) in Seneca County and one municipality (York Township) in Sandusky County, along with four school districts (Bellevue City School District, Clyde-Green Springs Exempted Village School District, Old Fort Local School District, Seneca East Local School District). Table 9 displays the total estimated PILOT revenues to be distributed throughout all taxing jurisdictions under the four scenarios identified in the payment schedule in Section 5727.75 of the ORC.

Table 9: Estimated Total PILOT Revenue

Total Facility capacity (MW)	PILOT at $6,000/MW	PILOT at $7,000/MW	PILOT at $8,000/MW	PILOT at $9,000/MW
200	$1,200,000	$1,400,000	$1,600,000	$1,800,000

Part VII: Conclusion

The socioeconomic effects of the Republic Wind Farm, when assessed in light of regional and local economic trends, will have a positive impact on the communities within the Study Area and across the State of Ohio. Lease payments, short- and long-term job creation, and PILOT revenues will benefit private landowners, businesses, and taxing jurisdictions. The Facility is not expected to generate significant expenditures on behalf of these beneficiaries; therefore, it will have a positive impact on the social and economic conditions of these communities and across Ohio.

1. Total Statewide Economic Benefit

   The construction of the Republic Wind Farm is expected to produce $41.1 million in employment earnings and $112.2 million in total economic output. Subsequently, each year the Facility is operational it is expected to generate approximately $2.3 million in earnings and $5.9 million in total economic output.

2. Statewide Employment Benefits

   During the construction period, the Facility is expected to support demand for a total of 753 onsite, supply chain, and induced employment positions. It is expected to support a total of 41 positions during each year of its operation.

3. Land Lease Revenues

   The development of the Facility will result in $[redacted] in annual lease payments made to participating landowners.

4. Property Tax Revenues

   Construction of the proposed Republic Wind Farm will increase local government revenues through payments in lieu of taxes (PILOTs). Though the agreements outlining these payments are not yet finalized, it is estimated that annual PILOT revenues could amount to approximately $1.2 million to $1.8 million to be distributed to local taxing jurisdictions.

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Appendix C: Economic and Fiscal Impact Study

Economic and Fiscal Impact of Seneca Wind

Seneca County, Ohio

July 2018

Prepared for

Seneca Wind LLC

Prepared by

TETRA TECH

Table of Contents

Introduction

Seneca Wind LLC (Seneca Wind) is proposing to develop the Seneca Wind project (the Project) in Seneca County, Ohio. The Project is a new 212-megawatt (MW)[1] wind-energy facility consisting of up to 85 wind turbine generators. The Project will be located on private lands within an area of approximately 56,900 acres in Seneca County (the Project Area). Land use within the Project Area is primarily agricultural. The Project will require significant capital investment, with construction expected to take place from the second quarter through the fourth quarter of 2019.

This report, prepared on behalf of Seneca Wind, assesses the economic and fiscal impact of the Project. Regional economic impacts are assessed using the National Renewable Energy Laboratory's (NREL's) Jobs and Economic Development Impact (JEDI) Land-based Wind Model (JEDI Wind Model) and presented in terms of employment, income, and economic output. Impacts are estimated separately at the state (Ohio) and local (Seneca County) levels. The fiscal impact analysis provides an estimate of tax revenues that would be expected to accrue as a result of Project construction and operation.

The results presented in this report are indicative, preliminary estimates based on a certain set of assumptions and estimated model inputs. These assumptions and inputs are based on the best data and information available at this stage in the Project development process. These assumptions and inputs could differ from actual conditions due to unexpected events or other Project-related developments, resulting in different economic and fiscal impacts. However, this analysis is anticipated to generally reflect the order of magnitude of expected impacts.

State and Local Context

Demographic Overview

Seneca County is located in north-central Ohio. The county encompasses 552 square miles, the majority of which (about 80 percent) is pasture land (WSOS Community Action Group 2011). With a total estimated population of 55,243 in 2017, Seneca County ranked 47 of 88 counties in Ohio in terms of population, with an average population density of 100.3 persons per square mile (persons/square mile) compared to a statewide average of 285.3 persons/square mile (U.S. Census Bureau 2018a, 2018b).

There are eight incorporated communities in Seneca County: the cities of Tiffin and Fostoria (part) and the villages of Attica, Bettsville, Bloomville, Green Springs (part), New Riegel, and Republic. These eight communities together account for about two-thirds of total county population. Tiffin, located west of the Project area is the county seat and the largest of the eight communities, with an estimated population of 17,701, followed by Fostoria (13,397) and Green Springs (1,637). The villages of Attica and Bloomville, with respective estimated populations of 1,018 and 915, are located within the boundaries of the Project Area (U.S. Census Bureau 2018c).[2]

Total population in Seneca County peaked in 1980 and has been declining since. The total population identified in the last decennial census (2010) was 56,745, roughly equal to the county's population in 1955. Total population dropped by 1,938 residents or 3.3 percent from 2000 to 2010, falling by a further 1,502 residents from 2010 to 2017, a 2.6 percent decrease (U.S. Census Bureau 2018b, WSOS Community Action Group 2011). The net loss of people from 2010 to 2017 was primarily the result of net out-migration

[1] The installed (nameplate) capacity would be 212 MW; however, a maximum of 200 MW would be generated per the interconnection agreement.

[2] The most recent population estimates for cities and towns with populations of less than 20,000 are 5-year estimates from the 2012-2016 American Community Survey (U.S. Census Bureau 2017c). Estimates are annual totals based on 5 years of data.

(more people left than moved to the county), with the county experiencing a very modest gain (20 people) through natural increase (more births than deaths) (U.S. Census Bureau 2018d).

The State of Ohio had a total estimated population of 11.66 million in 2017. Unlike Seneca County, the statewide population has been slowly growing, increasing by about 1.6 percent from 2000 to 2010, and by a further 1.1 percent from 2010 to 2017 (U.S. Census Bureau 2018a, 2018e).

Employment and the Economy

An estimated 27,294 people were employed in Seneca County in 2016 (Table 1). Employment was concentrated in the manufacturing sector, which accounted for 16 percent of total employment compared to just 10 percent statewide. Viewed in terms of number of establishments, fabricated metal products, machinery, and transportation equipment were the main clusters of manufacturing industries in 2009 (WSOS Community Action Group 2011). Employment in Seneca County is also relatively concentrated in education, which made up 6 percent of total employment in 2016, three times the state average (Table 1). The relative importance of education reflects the presence of two universities, a career/vocational school, and several school districts within the county. Employment in Seneca County in 2016 also included a total of 1,554 construction jobs (Table 1).

Table 1. Employment by Economic Sector, 2016

	Seneca County		State of Ohio	
Economic Sector	Number of Jobs[1]	Percent of Total	Number of Jobs[1]	Percent of Total
Agriculture	1,120	4	87,949	1
Forestry, Fishing, and Related	(D)	na	14,314	0
Mining	176	1	34,124	0
Utilities	115	0	20,576	0
Construction	1,554	6	326,254	5
Manufacturing	4,392	16	714,829	10
Wholesale Trade	971	4	269,484	4
Retail Trade	2,929	11	698,917	10
Transportation and Warehousing	1,141	4	258,303	4
Information	280	1	86,785	1
Finance and Insurance	863	3	334,294	5
Real Estate	1,061	4	274,701	4
Professional, Scientific, and Technical Services	(D)	na	394,559	6
Management of Companies	(D)	na	145,440	2
Administrative, Waste Management, Remediation	728	3	418,477	6
Arts, Entertainment, and Recreation	295	1	137,780	2
Accommodation and Food Services	2,075	8	505,339	7
Education	1,650	6	156,783	2

Table 1. Employment by Economic Sector, 2016

Economic Sector	Seneca County		State of Ohio	
	Number of Jobs[1]	Percent of Total	Number of Jobs[1]	Percent of Total
Health Care and Social Assistance	2,639	10	898,978	13
Other Services	1,619	6	377,953	5
Government	2,754	10	801,699	12
Total Employment	**27,294**	**100**	**6,957,538**	**100**

Notes:
na – not applicable
(D) Not shown to avoid disclosure of confidential information; estimates for this item are, however, included in the totals.
[1] Employment estimates include self-employed individuals. Employment data are by place of work, not place of residence, and, therefore, include people who work in the area but do not live there. Employment is measured as the average annual number of jobs, both full- and part-time, with each job counted at full weight.

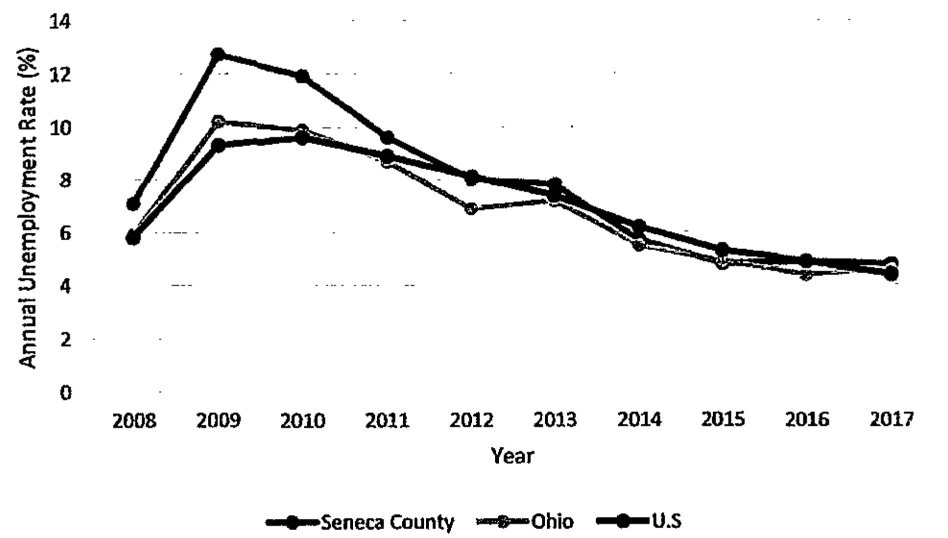
Source: U.S. Bureau of Economic Analysis 2018

The largest private employers in the county include Mercy Tiffin Hospital and Ameriwood Industries, each with more than 500 employees. A number of other businesses employ between 200 and 499 workers, including Church & Dwight, Mennel Milling, and National Machinery, among other manufacturing companies, and Heidelberg University and Tiffin University in the education sector (Seneca Industrial and Economic Development Corp 2018).

Almost 7 million people were employed in the state of Ohio in 2016. Health care and social assistance was the largest economic sector based on employment, accounting for 13 percent of total employment, followed by the government (12 percent), manufacturing (10 percent), and retail trade (10 percent) sectors (Table 1).

Annual unemployment rates for Seneca County, the State of Ohio, and the United States are presented in Figure 1. Unemployment in Seneca County peaked at the height of the recession in 2009, with an annual unemployment rate of 12.7 percent, substantially higher than the corresponding statewide (10.2 percent) and national averages (9.3 percent). Unemployment rates have declined in all three areas since 2010, with annual rates ranging from 4.4 percent (U.S.) to 4.8 percent (Seneca County) in 2017 (Figure 1). The drop in the annual unemployment rate in Seneca County has been accompanied by a drop in the number of workers in the labor force, with fewer people employed in the county in 2017 than 8 years earlier in 2009 (26,000 jobs in 2017 compared to 26,600 jobs in 2009) (Ohio Department of Job and Family Services 2018).

Figure 1. Annual Unemployment Rates, 2008 to 2017



Source: Ohio Department of Job and Family Services 2018

Tax Revenues

In Ohio, local government entities are allowed to levy *ad valorem* property taxes on real and personal property within their jurisdictions. Real property tax rates are levied locally and vary by taxing authority. The total tax rate for a parcel includes all applicable levies for the taxing jurisdictions that the parcel falls within. Taxing jurisdictions include school districts, counties, municipalities, townships, and special service districts, with each unique combination of these jurisdictions creating a separate taxing district. Assessed values are established by the County Auditor at 35 percent of appraised market value, with all property required to be reevaluated every 6 years. Seneca County is a primarily rural county with a significant agricultural and durable goods manufacturing base. The 2016 Annual Financial Report for Seneca County noted that the county's $1.19 billion assessed real property tax base for that year increased by 27 percent over the preceding 6 years, mainly due to residential real estate construction and reevaluations of property within Seneca County (Auditor of State 2017). A total of $58.4 million was collected in property tax revenues in Seneca County in 2017 (Ohio Department of Taxation 2017). This total includes revenues for all taxing jurisdictions within the county, including school districts, municipalities, townships, and special service districts, as well as the county itself.

Methodology

Economic Impact Analysis

The economic impact of the Project will occur in two phases: 1) the initial construction phase; and 2) following construction, the operations and maintenance (O&M) phase. This report assesses both phases using the JEDI Wind Model, with a separate analysis prepared for each phase. Impacts are assessed at the state (Ohio) and county (Seneca County) levels, resulting in four separate analyses. Construction and operation of the Project will generate economic benefits in local economies through direct expenditures for materials and services in the local area, and new payroll income. Benefits will also result from payments to landowners.

Wind energy projects in the State of Ohio can be exempted from tangible personal property and real property tax payments if they meet certain conditions. The following analysis assumes that Seneca Wind will meet these conditions and will instead make annual payments in lieu of taxes (PILOT) payments to the Seneca County Treasurer. These payments will also result in economic benefits.

The JEDI Model

The JEDI Wind model is a spreadsheet tool that applies standard input–output multipliers and consumption patterns using multiplier data derived from the IMPLAN (IMpact Analysis for PLANning) model. IMPLAN is a commercially available economic modeling package widely used to assess the economic impacts of renewable energy and many other types of projects.

The IMPLAN model divides the economy into 536 sectors including government, households, farms, and various industries, and models the linkages between the various sectors. The linkages are modeled through input-output tables that account for all dollar flows between different sectors of the economy. Using national industry and county-level economic data derived from the U.S. Bureau of Economic Analysis, U.S. Census, and other government sources, IMPLAN models how spending in one sector of the economy is spent and re-spent in other sectors of the economy. By tracing these linkages, the model approximates the flows of initial project spending through the local economy based on the supply lines connecting the various economic sectors. These linkages vary by sector and also through regional differences in spending and employment patterns. The amount spent locally decreases with each successive transaction away from the initial expenditure due to the effects of savings, taxes, or other activities that happen outside the local economy, known as leakages.

The economic relationships modeled by IMPLAN are embedded in the multipliers used by the JEDI Wind Model, which allows the user to estimate the overall change in the economy that would result from construction and operation of a wind generating facility. The dollars spent on a project's construction and operation within a state or county are analyzed to determine the total economic impact within the local area. The direct investments in project construction and operation trigger successive rounds of spending that result in an overall increase in employment, income, and output in the local economy. Construction-related impacts are assessed as one-time impacts; O&M-related impacts are modeled as annual impacts.

The JEDI Wind Model combines user inputs and industry-average values to develop overall project costs and allocate expenditures among different sectors of the economy. NREL developed the industry average values used in the model from extensive interviews with power generation project developers, state tax representatives, and others in the appropriate industries. The model allows the user to modify the default average values to incorporate project-specific data, including construction material and labor costs, estimated payments to landowners, and local tax payments, as well as the shares of specific expenditures expected to occur within the analysis area.

The standard JEDI model assesses potential impacts at the state level, using corresponding state-level multipliers derived from IMPLAN. Using Project-specific inputs, this version of the model was used to estimate impacts at the state level for Ohio. In addition, a county-specific version of the model was developed using 2016 IMPLAN data for Seneca County and the JEDI Wind Model's User Add-in Location feature. This model was used to assess economic impacts at the county level for Seneca County.

Impact Types

Total economic impacts reported by the JEDI Wind Model consist of three components.[3] These components are reported separately for the construction and operation phases of the Project.

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[3] These categories were re-labeled in more recent versions of the JEDI Wind model "to reflect a more accurate description of these impacts and facilitate user interpretation of model results" (NREL 2017). Project Development and On-Site Labor Impacts were previously labeled Direct Impacts. Turbine/Local Revenue and Supply Chain Impacts were identified as Indirect Impacts. The original naming conventions are more consistent with IMPLAN and other input-

Construction Impact Types:

- ***Project Development and On-Site Labor Impacts:*** This component consists of expenditures on labor (wages and salaries and associated impacts) for workers engaged in on-site construction and people providing professional services in support of the Project. Typical on-site workers include road builders, concrete-pouring companies, construction companies, tower erection crews, and crane operators. Typical professional services include Project developers, and environmental and permitting consultants.
- ***Turbine and Supply Chain Impacts:*** This component includes the materials and equipment necessary for the Project (e.g., turbines, blades, and towers), and the smaller components that make up the balance of the system (e.g., wiring, inverters, mountings, and transformers), as well as the supply chain of inputs required to produce these materials.
- ***Induced Impacts:*** These impacts result from the spending of households associated either directly or indirectly with the Project. Workers employed during construction, for example, will use their income to purchase groceries and other household goods and services. Workers at businesses that supply the Project during construction will do the same. Induced effects are sometimes referred to as "consumption-driven" impacts.

Operation Impact Types:

- ***On-Site Labor Impacts:*** This component consists of expenditures on labor (wages and salaries and associated impacts) for workers engaged in on-site operation of the Project, including site technicians, administration, and management.
- ***Local Revenue and Supply Chain Impacts:*** This component includes expenditures on goods and services by suppliers who provide goods and services to the Project, as well as payments related to landowner leases and property tax or PILOT contributions.
- ***Induced Impacts:*** These impacts result from the spending of households associated either directly or indirectly with the Project.

Impact Measures

Impacts are assessed using the following measures as reported by the JEDI Wind Model:

- ***Employment:*** Jobs are expressed in the JEDI Wind Model as FTEs, or 2,080-hour units of labor (one job equates to one full-time job for one year). Part-time or temporary jobs constitute a fraction of a job. For example, if an engineer works just 3 months on a wind project, that would be considered one-quarter of a job by the JEDI Wind Model.
- ***Earnings (or labor Income):*** Earnings are expressed as the sum of employee compensation and proprietary income.
- ***Output:*** Output represents the total value of goods and services produced as a result of the Project, and serves as a broad measure of economic activity.

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output models. The first category presented here does, however, differ from the typical Direct Impacts reported by IMPLAN and other input-output models because it is based on labor expenditures only and does not include direct expenditures on materials, which are included as part of the second category reported by the JEDI Wind Model.

Impact Sources

Construction

Project construction is expected to take place in 2019, with construction activities expected to extend from the second quarter through the fourth quarter. Based on similar project experience, Seneca Wind estimates that Project construction will directly employ from 175 to 250 workers on-site, including construction workers, engineers, electricians, equipment operators, and a number of other contractors and service providers.

Construction costs for this analysis were provided by Seneca Wind. These cost estimates were used in conjunction with more detailed industry-average values provided by the JEDI Wind Model to adjust the average model input values to more accurately reflect the proposed Project. The largest share of the overall construction cost is the purchase and transportation of the equipment (turbines, blades, and towers) to the Project site. The JEDI Wind Model default settings assume that this component accounts for approximately 75 percent of the total construction costs. The Project-specific estimates developed by Seneca Wind indicated that this component would comprise a smaller, but still substantial share of the total Project costs. Expenditures related to this construction component are expected to occur outside the State of Ohio.

Balance-of-plant activities make up a second broad category of costs. Balance-of-plant activities assessed in the model include materials, labor, and development and other costs. The materials portion includes concrete, rebar and other construction materials as well as the electrical components and cabling required to prepare the site and connect the turbines. The labor component includes the site work, foundations, electrical, erection, and other associated labor needed to construct the Project. Development and other costs include legal fees, engineering, site certificates, and other miscellaneous expenditures. The shares of these expenditures expected to be made locally (either in-state or in Seneca County) are estimated by the JEDI Wind Model. These estimates were reviewed with adjustments made to reflect local conditions and Project-specific information.

Operation

Once the construction phase is complete, O&M of the Project will continue to contribute to the local economy. The Project will provide direct O&M-related employment, and Project-related O&M expenditures will generate economic benefits in the local economy. Typical local O&M-related expenditures include vehicle-related expenditures, such as fuel costs, site maintenance, replacement parts and equipment, and miscellaneous supplies. Project-specific O&M costs developed by Seneca Wind were used for this analysis.

Lease payments to landowners will also generate annual benefits to the local economy over the life of the Project. In most cases these payments represent a net increase in income for the landowner. Each turbine occupies a relatively small footprint when compared to the site as a whole and landowners can usually continue farming and livestock operations on their property. Seneca Wind estimates that landowner payments will total more than $20 million over the life of the Project. These estimated payments were used to modify the default values estimated by the JEDI Wind Model. The impact of these payments is assessed by the model as an increase in household income.

Wind energy projects in the State of Ohio may be exempted from tangible personal property and real property tax payments if they meet certain conditions. This analysis assumes that Seneca Wind will meet these conditions and will instead make an annual PILOT payment of $9,000 per MW (as discussed below).

Economic Impacts

Construction and operation related impacts are presented below for Ohio and Seneca County in turn. It should be noted that impacts estimated for Seneca County are substantially lower than those modeled for the state as a whole because there are greater leakages of expenditures at the county level, resulting in larger benefits at the state level. Further, the state-level evaluation also captures Project-related spending elsewhere in Ohio (i.e., outside Seneca County).

Construction Phase Impacts in the State of Ohio

Estimated construction phase impacts for the State of Ohio are summarized in Table 2. These estimates are one-time impacts developed using the JEDI Wind Model for Ohio. Job estimates are presented in FTEs, with each identified job representing 12 months (2,080 hours) of employment. Construction of the Project is expected to involve 99 on-site FTE jobs that would be filled by Ohio residents. Additional on-site positions that would be filled by out-of-state workers are not included in these estimates. Spending by out-of-state workers is, however, captured in the induced impact estimates. On-site jobs expected to be filled by Ohio workers include those associated with site work, foundations, electrical work, tower erection, and other associated labor needed to construct the plant. In addition, an estimated 22 construction-related service positions would be filled by Ohio workers. Jobs falling under the category of construction-related services include civil and electrical engineers, attorneys, and permitting specialists. Workers with more specialized skills, such as turbine assemblers, crane operators, and high voltage electrical workers are expected to come from outside the state, remaining only for the duration of their employment.

Table 2. Construction Phase Impacts in Ohio

Impact Type/Measure	Jobs[1]	Earnings ($ million)[2]	Output ($ million)[2]
Project Development and Onsite Labor Impacts	121	$8.89	$10.72
Construction and Interconnection Labor	99	$7.74	--
Construction Related Services	22	$1.15	--
Turbine and Supply Chain Impacts	479	$27.23	$90.75
Induced Impacts	195	$10.59	$31.15
Total Impacts	**795**	**$46.71**	**$132.62**

Notes:

[1] Jobs are FTE for a period of one year (1 FTE = 2,080 hours). Project development and onsite labor jobs and earnings include only those positions that would be filled by Ohio residents. Positions filled by out-of-state workers are not included in these estimates. Spending by out-of-state workers is, however, captured in the induced impact estimates.

[2] Earnings and output are expressed in millions of dollars in Year 2018 dollars.

Construction of the Project would also support employment, income, and output elsewhere in the state, with turbine and supply chain impacts expected to support 479 jobs in Ohio and induced impacts expected to support 195 jobs (Table 2). A majority of the estimated 479 turbine and supply chain jobs are expected to occur in the construction sector as a result of in-state expenditures on materials, specifically concrete and rebar, equipment, roads, and site preparation. The total also includes jobs in the retail, professional services, and manufacturing sectors, based on expenditures on materials, as well as estimated in-state expenditures on balance-of-plant labor (for example, foundation and electrical work, hauling, and tractor operation). Overall, construction of the Project is expected to support 795 total jobs in Ohio and approximately $46.7 million in earnings, with total output of approximately $132.6 million.

Annual Operation Phase Impacts in the State of Ohio

Estimated operation phase impacts for the State of Ohio are summarized in Table 3. These estimates are annual average impacts developed using the JEDI Wind Model for Ohio. Operation of the Project is expected to provide direct employment for 11 workers, all of whom would reside in Ohio. Operation and maintenance of the Project would also support employment, earnings, and output elsewhere in the state, with local revenue and supply chain impacts expected to support 14 jobs in Ohio and induced impacts expected to support an additional 14 jobs (Table 3). Overall, operation of the Project is expected to support 39 total jobs in Ohio and approximately $2.4 million in earnings, with total output of approximately $7.8 million. These annual average impacts are expected to occur over the life of Project operation.

Table 3. Annual Operation Phase Impacts in Ohio

Impact Type/Measure	Jobs[1]	Earnings ($ million)[2]	Output ($ million)[2]
Onsite Labor Impacts	11	$0.60	$0.60
Local Revenue and Supply Chain Impacts	14	$0.94	$4.73
Induced Impacts	14	$0.82	$2.42
Total Impacts	**39**	**$2.36**	**$7.75**

Notes:
[1] *Jobs are FTE for a period of one year (1 FTE = 2,080 hours).*
[2] Earnings and output are expressed in millions of dollars in Year 2018 dollars.

Construction Phase Impacts in Seneca County, Ohio

The Project's estimated construction phase impacts for Seneca County are summarized in Table 4. These estimates are one-time impacts estimated using a county-specific version of the JEDI Wind Model that was developed using 2016 IMPLAN data for Seneca County and the JEDI Wind Model's User Add-in Location feature. Construction of the Project is expected to directly employ approximately 10 workers from Seneca County on-site during the construction period. Positions filled by workers from elsewhere in Ohio and out-of-state are not included in these estimates. Spending by non-resident workers in Seneca County is, however, captured in the induced impact estimates.

The construction and interconnection labor estimates presented in Table 4 are conservative estimates and assume that only a small share of the construction workers estimated to be hired in-state (i.e., workers normally resident in Ohio) would be hired from within Seneca County. These estimates are likely conservative because an estimated annual average of 1,554 construction job were identified in Seneca County in 2016 (Table 1), which suggests that a sizeable construction workforce exists within the county. These workers likely have the necessary skills to fill on-site jobs associated with tasks, such as site work, foundations, and general electrical work. In addition, data from the IMPLAN model indicates that an estimated 141 workers were employed in the Construction of new power and communication structures sector (the IMPLAN sector that includes construction of power plants and electric and communication transmission lines) in Seneca County in 2016. This suggests that more specialized workers may also be available for hire within the county.

Construction of the Project would also support employment, income, and output elsewhere in the county, with turbine and supply chain impacts expected to support 31 jobs in Seneca County and induced impacts expected to support an additional 9 jobs (Table 4). Similar to the construction and interconnection labor estimates, the turbine and supply chain impacts in Table 4 are likely conservative estimates because they assume that only a small share of the expenditures on materials estimated to occur in-state would occur in

Seneca County. Materials estimated to be purchased in-state include concrete and rebar, and equipment, as well as materials related to roads and site preparation. Overall, construction of the Project is expected to support 49 total jobs in Seneca County and approximately $2.4 million in earnings, with total output of approximately $7.6 million.

Table 4. Construction Phase Impacts in Seneca County, Ohio

Impact Type/Measure	Jobs[1]	Earnings ($ million)[2]	Output ($ million)[2]
Project Development and Onsite Labor	10	$0.77	$0.77
Construction and Interconnection Labor	10	$0.77	--
Construction Related Services	0	$0.00	--
Turbine and Supply Chain Impacts	31	$1.31	$5.69
Induced Impacts	9	$0.29	$1.08
Total Impacts	**49**	**$2.36**	**$7.54**

Notes:
[1] Jobs are FTE for a period of one year (1 FTE = 2,080 hours). Project development and onsite labor jobs and earnings include only those positions that would be filled by Ohio residents. Positions filled by workers from elsewhere in Ohio and out-of-state are not included in these estimates. Spending by non-resident workers in Seneca County is, however, captured in the induced impact estimates.
[2] Earnings and output are expressed in millions of dollars in Year 2018 dollars.

Annual Operation Phase Impacts in Seneca County, Ohio

Estimated operation phase impacts for Seneca County are summarized in Table 5. These estimates are annual average impacts developed using the JEDI Wind Model for Seneca County. Operation of the Project is expected to provide direct employment for 11 workers, all of whom would reside in Seneca County. Project O&M would also support employment, earnings, and output elsewhere in the county, with local revenue and supply chain impacts expected to support 13 jobs in Seneca County and induced impacts expected to support an additional 4 jobs (Table 5). Estimated annual impacts include the effects of lease payments to landowners, which Seneca Wind estimates will total more than $20 million over the life of the Project. Overall, operation of the Project is expected to support 27 total jobs in Seneca County and approximately $1.2 million in earnings, with total output of approximately $4.6 million. These annual average impacts are expected to occur over the life of Project operation.

Table 5. Annual Operation Phase Impacts in Seneca County, Ohio

Impact Type/Measure	Jobs[1]	Earnings ($ *million*)[2]	Output ($ *million*)[2]
Onsite Labor Impacts	11	$0.59	$0.59
Local Revenue and Supply Chain Impacts	13	$0.45	$3.60
Induced Impacts	4	$0.11	$0.43
Total Impacts	**27**	**$1.16**	**$4.63**

Notes:
[1] Jobs are FTE for a period of one year (1 FTE = 2,080 hours).
[2] Earnings and output are expressed in millions of dollars in Year 2018 dollars.

Tax Revenues

Wind energy projects in the State of Ohio may be exempted from tangible personal property and real property tax payments if they meet certain conditions as provided in Ohio Revised Code (ORC) Section 5727.75. Qualified energy projects that receive this exemption are instead required to make annual PILOT payments. Annual PILOT payments are determined based on the size of the Project and the share of the construction workforce normally resident in the State of Ohio.

According to ORC 5727.75, tangible personal property of a qualified energy project using renewable energy resources is exempt from taxation for tax years 2011 through 2021 if all of the following conditions are satisfied:

- An application is filed for certification of the energy project as a qualified energy project with the director of the Ohio Development Services Agency on or before December 31, 2020.
- An application is filed with the Ohio Power Siting Board (OPSB) for a certificate under ORC section 4906.20.
- The county commissioners of a county in which the energy project is located either adopt a resolution approving the application submitted to the Ohio Development Services Agency or pass a resolution declaring the county an alternative energy zone (AEZ).
- Construction is initiated by January 1, 2021, with construction defined as either the date the application is filed with the OPSB or the date the contract for construction or installation is entered into, whichever is earlier.

If the applicant is granted an exemption from taxation from any of the tax years 2011 through 2021, the qualified energy project is also exempt from taxation for tax year 2022 and all following years.

Estimated PILOT "base" payments range from $6,000 per MW of nameplate capacity for projects where the majority (75 percent or more) of total construction jobs (measured in FTEs) are filled by workers normally resident in Ohio to $8,000 per MW for projects where Ohio residents account for a smaller share (50 to 60 percent) of total employment. PILOT payments are $7,000 per MW of nameplate capacity for projects where 60 to 75 percent of the construction workforce consists of Ohio residents. Under ORC 5727.75, county commissioners may also require an additional service payment, with a combined service and PILOT ("base") payment not to exceed $9,000 per MW.

The Board of Seneca County Commissioners adopted a resolution designating Seneca County as an AEZ in October 2011, with an annual service payment required in addition to the annual "base" payment of $6,000 to $8,000 per MW (Seneca County Commissioners' Office 2011). The amount of each service payment shall be the difference between $9,000 and the "base" payment per MW required under ORC 5727.75. The funds derived from the "base" payment will be distributed to taxing districts in accordance with the applicable millage in the respective taxing districts, with the additional service payments dispersed as decided by the Board of County Commissioners (Seneca County Commissioners' Office 2011).

Seneca Wind anticipates that it will make payments in lieu of real and personal property taxes in accordance with the applicable statute (ORC 5727.75) and the Board of Seneca County Commissioners' 2011 resolution (Seneca County Commissioners' Office 2011). For the Project, with a nameplate capacity of 212 MW, the combined "base" and service payment of $9,000 per MW will result in annual payments of $1.91 million during its first year of operation, and each year thereafter. This estimated total of $1.91 million is equivalent to 3.3 percent of total property tax revenues for all taxing jurisdictions in Seneca County, which were 58.4 million in 2017 (Ohio Department of Taxation 2017).

Conclusion

The preceding analysis estimates the economic and fiscal impacts associated with construction and operation of the proposed Project at the local (Seneca County) and state levels. Impacts were estimated for each geographic area, state and county, using separate JEDI Wind Models. The results of this analysis indicate that construction and operation of the Project would provide direct employment for residents in Seneca County and elsewhere in-state, as well as support economic activity elsewhere in the local and state economies.

Overall, construction of the Project is estimated to support 795 total (Project Development and On-Site, Turbine and Supply Chain, and Induced) jobs in the State of Ohio, and approximately $46.7 million in labor income, with total economic output of approximately $132.6 million. In Seneca County, Project construction is estimated to support approximately 49 total jobs and approximately $2.4 million in labor income, with total economic output of approximately $7.6 million. Construction impacts would be one-time impacts that would occur only during construction.

Operation of the Project is estimated to support approximately 39 total (direct, indirect, and induced) jobs in the State of Ohio and approximately $2.4 million in labor income, with total economic output of approximately $7.8 million. In Seneca County, Project operation is estimated to support approximately 27 full-time jobs and approximately $1.2 million in labor income, with total economic output of approximately $4.6 million. These annual average impacts are expected to occur over the life of Project operation.

Seneca Wind anticipates that it will make payments in lieu of real and personal property taxes in accordance with the applicable statute (ORC 5727.75) and the Board of Seneca County Commissioners' 2011 resolution (Seneca County Commissioners' Office 2011), with the Project estimated to generate $1.91 million in PILOT payments during its first year of operation, and each year thereafter. Seneca Wind also estimates that lease payments to landowners will total more than $20 million over the life of the Project.

Qualifications of the Preparer

This report was prepared by Matt Dadswell of Tetra Tech, with inputs provided by Seneca Wind LLC, as referenced in the report. Mr. Dadswell has a first class, joint honors, bachelor's degree in Economics and Geography from Portsmouth Polytechnic in England; a master's degree in Geography from the University of Cincinnati; and completed two years of doctoral study in Geography at the University of Washington. Mr. Dadswell has 24 years of experience preparing economic and social analyses for energy projects throughout the United States.

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ADAMS TWP - BELLEVUE CSD
Apex - Republic Wind Project
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75					
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL		
3.63 X	$9,000	$32,670	3	$98,010	$98,010		
To SENECA County General Fund							
3.63X3=	10.89 MW x 3 =		10.89		County GF portion		$10,890

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	2.8563	2.8563	$2,799	$311	$2,488
8.70	Opportunity Center	13.0788	13.0788	$12,819	$1,424	$11,394
41.60	Bellevue Schools	62.5376	62.5376	$61,293	$6,810	$54,483
4.45	EHOVE Career Center	6.6897	6.6897	$6,557	$729	$5,828
7.07	Adams Township	10.6284	10.6284	$10,417	$1,157	$9,259
0.30	Health District	0.4510	0.4510	$442	$49	$393
1.00	Bellevue Library	1.5033	1.5033	$1,473	$164	$1,310
0.30	Commission on Aging	0.4510	0.4510	$442	$49	$393
0.70	Mental Health & Recovery	1.0523	1.0523	$1,031	$115	$917
0.50	County Park District	0.7517	0.7517	$737	$82	$655
66.52		100.00		$98,010	$10,890	$87,120

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

ADAMS TWP - CLYDE EVSD

Apex - Republic Wind Project

All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75					
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL		
3.63 X	$9,000	$32,670	3	$98,010	$98,010		
To SENECA County General Fund							
3.63X3=	10.89 MW x 3 =		10.89			County GF portion	$10,890

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	2.6218	2.6218	$2,570	$286	$2,284
8.70	Opportunity Center	12.0050	12.0050	$11,766	$1,307	$10,459
50.40	Clyde EVSD	69.5460	69.5460	$68,162	$7,574	$60,588
1.60	Vanguard JVSD	2.2078	2.2078	$2,164	$240	$1,923
7.07	Adams Township	9.7558	9.7558	$9,561	$1,063	$8,499
0.30	Health District	0.4140	0.4140	$406	$45	$361
1.00	Birchard Public Library	1.3799	1.3799	$1,352	$150	$1,202
0.30	Commission on Aging	0.4140	0.4140	$406	$45	$361
0.70	Mental Health & Recovery	0.9659	0.9659	$947	$105	$842
0.50	County Park District	0.6899	0.6899	$676	$75	$601
72.47		100.00		$98,010	$10,890	$87,120

Information provided from Dalton Carr, Apex Clean Energy 4/10/18

Julie A. Adkins, Seneca County Auditor

Dated: May 11, 2018

ADAMS TWP - OLD FORT LSD

Apex - Republic Wind Project

All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75				
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL	
3.63 X	$9,000	$32,670	1	$32,670	$32,670	
To SENECA County General Fund						
3.63X1=	3.63 MW x 1 =		3.63		County GF portion	$3,630

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	2.75	2.75	$898	$100	$798
8.70	Opportunity Center	12.59	12.59	$4,112	$457	$3,655
47.05	Old Fort LSD	68.07	68.07	$22,238	$2,470	$19,769
1.60	Vanguard JVSD	2.31	2.31	$756	$84	$672
7.07	Adams Township	10.23	10.23	$3,342	$371	$2,970
0.30	Health District	0.43	0.43	$142	$16	$126
1.00	Tiffin-Seneca Public Library	1.45	1.45	$473	$53	$420
0.30	Commission on Aging	0.43	0.43	$142	$16	$126
0.70	Mental Health & Recovery	1.01	1.01	$331	$37	$294
0.50	County Park District	0.72	0.72	$236	$26	$210
69.12		100.00		$32,670	$3,630	$29,040

Information provided from Dalton Carr, Apex Clean Energy 4/10/18

Julie A. Adkins, Seneca County Auditor

Dated: May 11, 2018

ADAMS TWP - SENECA EAST LSD
Apex - Republic Wind Project
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75			
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL
3.63 X	$9,000	$32,670	7	$228,690	$228,690

To SENECA County General Fund
3.63X7= 25.41 MW x 7 = 25.41 County GF portion $25,410

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.3557	3.3557	$7,674	$853	$6,821
8.70	Opportunity Center	15.3656	15.3656	$35,140	$3,904	$31,235
34.80	Seneca East LSD	61.4624	61.4624	$140,558	$15,617	$124,942
1.60	Vanguard JVSD	2.8259	2.8259	$6,462	$718	$5,744
7.07	Adams Township	12.4868	12.4868	$28,556	$3,173	$25,383
0.30	Health District	0.5298	0.5298	$1,212	$135	$1,077
0.75	Seneca East Library	1.3246	1.3246	$3,029	$337	$2,693
0.30	Commission on Aging	0.5298	0.5298	$1,212	$135	$1,077
0.70	Mental Health & Recovery	1.2363	1.2363	$2,827	$314	$2,513
0.50	County Park District	0.8831	0.8831	$2,020	$224	$1,795
56.62		100.00		$228,690	$25,410	$203,280

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

Republic Wind Project - 14 Turbines
ADAMS TOWNSHIP RECAP

	ADAMS TWP - BELLEVUE CSD		ADAMS TWP - CLYDE EVSD		ADAMS TWP - OLD FORT LSD		ADAMS TWP - SENECA EAST LSD	TOTALS
Generators	3		3		1		7	
$1K to General Fund	$10,890		$10,890		$3,630		$25,410	$50,820
County General Fund	$2,488		$2,284		$798		$6,821	$12,392
Opportunity Center	$11,394		$10,459		$3,655		$31,235	$56,743
Bellevue Schools	$54,483							$54,483
Clyde EVSD			$60,588					$60,588
Old Fort LSD					$19,769			$19,769
Seneca East LSD							$124,942	$124,942
EHOVE Career Center	$5,828							$5,828
Vanguard JVSD			$1,923		$672		$5,744	$8,340
Adams Township	$9,259		$8,499		$2,970	Adams Township	$25,383	$46,112
Health District	$393		$361		$126	Health District	$1,077	$1,957
Bellevue Library	$1,310							$1,310
Birchard Public Library			$1,202					$1,202
Tiffin-Seneca Public Library					$420			$420
Seneca East Library							$2,693	$2,693
Commission on Aging	$393	Commission on Aging	$361	Commission on Aging	$126	Commission on Aging	$1,077	$1,957
Mental Health & Recovery	$917	Mental Health & Recovery	$842	Mental Health & Recovery	$294	Mental Health & Recovery	$2,513	$4,566
County Park District	$655	County Park District	$601	County Park District	$210	County Park District	$1,795	$3,261
	$87,120		$87,120		$29,040		$203,280	$406,560

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

PLEASANT TWP - OLD FORT LSD
Apex - Republic Wind Project
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75				
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL	
3.63 X	$9,000	$32,670	3	$98,010	$98,010	
To SENECA County General Fund						
3.63X3=	10.89 MW x 3 =	10.89			County GF portion	$10,890

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	2.8464	2.8464	$2,790	$310	$2,480
8.70	Opportunity Center	13.0337	13.0337	$12,774	$1,419	$11,354
47.05	Old Fort	70.4869	70.4869	$69,086	$7,676	$61,409
1.60	Vanguard JVSD	2.3970	2.3970	$2,349	$261	$2,088
4.70	Pleasant Township	7.0412	7.0412	$6,901	$767	$6,133
0.30	Health District	0.4494	0.4494	$440	$49	$392
1.00	Tiffin-Seneca Public Library	1.4981	1.4981	$1,468	$163	$1,305
0.30	Commission on Aging	0.4494	0.4494	$440	$49	$392
0.70	Mental Health & Recovery	1.0487	1.0487	$1,028	$114	$914
0.50	County Park District	0.7491	0.7491	$734	$82	$653
66.75		100.00		$98,010	$10,890	$87,120

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

Republic Wind Project - 3 Turbines
PLEASANT TOWNSHIP RECAP

	PLEASANT TWP - OLD FORT LSD
Generators	3
$1K to Keneral Fund	$10,890
County General Fund	$2,480
Opportunity Center	$11,354
Old Fort	$61,409
Vanguard JVSD	$2,088
Pleasant Township	$6,133
Health District	$392
Tiffin-Seneca Public Library	$1,305
Commission on Aging	$392
Mental Health & Recovery	$914
County Park District	$653
	$87,120

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

REED TWP - BELLEVUE CSD
Apex - Republic Wind Project
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75				
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL	
3.63 X	$9,000	$32,670	1	$32,670	$32,670	
To SENECA County General Fund						
3.63X1	3.63 MW x 1 =		3.63		County GF portion	$3,630

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	2.8148	2.8148	$920	$102	$817
8.70	Opportunity Center	12.8889	12.8889	$4,211	$468	$3,744
41.60	Bellevue CSD	61.6296	61.6296	$20,134	$2,237	$17,898
4.45	EHOVE JVSD	6.5926	6.5926	$2,154	$239	$1,914
3.30	Reed Township	4.8889	4.8889	$1,597	$177	$1,420
0.30	Health District	0.4444	0.4444	$145	$16	$129
1.00	Bellevue Public Library	1.4815	1.4815	$484	$54	$430
0.30	Commission on Aging	0.4444	0.4444	$145	$16	$129
0.70	Mental Health & Recovery	1.0370	1.0370	$339	$38	$301
0.50	County Park District	0.7407	0.7407	$242	$27	$215
3.25	AVR Fire District	4.8148	4.8148	$1,573	$175	$1,398
1.50	AVR Jt Ambulance District	2.2222	2.2222	$726	$81	$645
67.50		100.00		$32,670	$3,630	$29,040

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

REED TWP - SENECA EAST LSD
Apex - Republic Wind Project
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75					
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL		
3.63 X	$9,000	$32,670	9	$294,030	$294,030		
To SENECA County General Fund							
3.63X9	32.67 MW x 9 =		32.67		County GF portion		$32,670

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.2986	3.2986	$9,699	$1,078	$8,621
8.70	Opportunity Center	15.1042	15.1042	$44,411	$4,935	$39,476
34.80	Seneca East LSD	60.4167	60.4167	$177,644	$19,737	$157,906
1.60	Vanguard JVSD	2.7778	2.7778	$8,168	$908	$7,260
3.30	Reed Township	5.7292	5.7292	$16,845	$1,872	$14,974
0.30	Health District	0.5208	0.5208	$1,531	$170	$1,361
0.75	Seneca East Public Library	1.3021	1.3021	$3,829	$425	$3,403
0.30	Commission on Aging	0.5208	0.5208	$1,531	$170	$1,361
0.70	Mental Health & Recovery	1.2153	1.2153	$3,573	$397	$3,176
0.50	County Park District	0.8681	0.8681	$2,552	$284	$2,269
3.25	AVR Fire District	5.6424	5.6424	$16,590	$1,843	$14,747
1.50	AVR Jt Ambulance District	2.6042	2.6042	$7,657	$851	$6,806
57.60		100.00		$294,030	$32,670	$261,360

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

Republic Wind Project - 10 Turbines

REED TOWNSHIP RECAP

	REED TWP - BELLEVUE CSD	REED TWP - SENECA EAST LSD	TOTALS
Generators	1	9	
$1K to General Fund	$3,630	$32,670	$36,300
County General Fund	$817	$8,621	$9,439
Opportunity Center	$3,744	$39,476	$43,220
Bellevue CSD	$17,898		$17,898
Seneca East LSD		$157,906	$157,906
EHOVE JVSD	$1,914		$1,914
Vanguard JVSD		$7,260	$7,260
Reed Township	$1,420	$14,974	$16,393
Health District	$129	$1,361	$1,490
Bellevue Public Library	$430		$430
Seneca East Public Library		$3,403	$3,403
Commission on Aging	$129	$1,361	$1,490
Mental Health & Recovery	$301	$3,176	$3,477
County Park District	$215	$2,269	$2,484
AVR Fire District	$1,398	$14,747	$16,145
AVR Jt Ambulance District	$645	$6,806	$7,452
	$29,040	$261,360	$290,400

Information provided from Dalton Carr, Apex Clean Energy 4/10/18

Julie A. Adkins, Seneca County Auditor

Dated: May 11, 2018

SCIPIO TWP - SENECA EAST LSD
Apex - Republic Wind Project
All amounts are calculated on the full tax rate

Annual Service Payments	ORC 5727.75					
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL	
3.63 X	$9,000	$32,670	10	$326,700	$326,700	
To SENECA County General Fund						
3.63X10	36.30 MW x 10 =	36.3			County GF portion	$36,300

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.2992	3.2992	$10,778	$1,198	$9,581
8.70	Opportunity Center	15.1068	15.1068	$49,354	$5,484	$43,870
34.80	Seneca East	60.4272	60.4272	$197,415	$21,934	$175,479
1.60	Vanguard JVSD	2.7783	2.7783	$9,077	$1,009	$8,068
6.50	Scipio Township	11.2867	11.2867	$36,874	$4,097	$32,777
0.30	Health District	0.5209	0.5209	$1,702	$189	$1,513
0.75	Seneca East Public Library	1.3023	1.3023	$4,255	$473	$3,782
0.30	Commission on Aging	0.5209	0.5209	$1,702	$189	$1,513
0.70	Mental Health & Recovery	1.2155	1.2155	$3,971	$441	$3,530
0.50	County Park District	0.8682	0.8682	$2,836	$315	$2,521
1.54	Bloom-Scipio Jt Amb District	2.6741	2.6741	$8,736	$971	$7,766
57.59		100.00		$326,700	$36,300	$290,400

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

Republic Wind Project - 10 Turbines
SCIPIO TOWNSHIP RECAP

	SCIPIO TWP - SENECA EAST LSD
Generators	10
$1K to General Fund	$36,300
County General Fund	$9,581
Opportunity Center	$43,870
Seneca East	$175,479
Vanguard JVSD	$8,068
Scipio Township	$32,777
Health District	$1,513
Seneca East Public Library	$3,782
Commission on Aging	$1,513
Mental Health & Recovery	$3,530
County Park District	$2,521
Bloom-Scipio Jt Amb Distric	$7,766
	$290,400

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

THOMPSON TWP - BELLEVUE CSD
Apex - Republic Wind Project
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75					
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL		
3.63 X	$9,000	$32,670	14	$457,380	$457,380		
To SENECA County General Fund							
3.63X14	50.82 MW x 14 =		50.82		County GF portion		$50,820

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	2.8379	2.8379	$12,980	$1,442	$11,538
8.70	Opportunity Center	12.9948	12.9948	$59,435	$6,604	$52,831
41.60	Bellevue CSD	62.1359	62.1359	$284,198	$31,577	$252,620
4.45	EHOVE JVSD	6.6468	6.6468	$30,401	$3,378	$27,023
7.50	Thompson Township	11.2024	11.2024	$51,238	$5,693	$45,544
0.30	Health District	0.4481	0.4481	$2,049	$228	$1,822
1.00	Bellevue Public Library	1.4937	1.4937	$6,832	$759	$6,073
0.30	Commission on Aging	0.4481	0.4481	$2,049	$228	$1,822
0.70	Mental Health & Recovery	1.0456	1.0456	$4,782	$531	$4,251
0.50	County Park District	0.7468	0.7468	$3,416	$380	$3,036
66.95		100.00		$457,380	$50,820	$406,560

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

THOMPSON TWP - SENECA EAST LSD

Apex - Republic Wind Project

All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75				
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL	
3.63 X	$9,000	$32,670	3	$98,010	$98,010	
To SENECA County General Fund						
3.63X3	10.89 MW x 3 =		10.89		County GF portion	$10,890

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.3304	3.3304	$3,264	$363	$2,901
8.70	Opportunity Center	15.2498	15.2498	$14,946	$1,661	$13,286
34.80	Seneca East LSD	60.9991	60.9991	$59,786	$6,643	$53,143
1.60	Vanguard JVSD	2.8046	2.8046	$2,749	$305	$2,443
7.50	Thompson Township	13.1464	13.1464	$12,885	$1,432	$11,453
0.30	Health District	0.5259	0.5259	$515	$57	$458
0.75	Seneca East Public Library	1.3146	1.3146	$1,288	$143	$1,145
0.30	Commission on Aging	0.5259	0.5259	$515	$57	$458
0.70	Mental Health & Recovery	1.2270	1.2270	$1,203	$134	$1,069
0.50	County Park District	0.8764	0.8764	$859	$95	$764
57.05		100.00		$98,010	$10,890	$87,120

Information provided from Dalton Carr, Apex Clean Energy 4/10/18

Julie A. Adkins, Seneca County Auditor

Dated: May 11, 2018

Republic Wind Project - 17 Turbines
THOMPSON TOWNSHIP RECAP

	THOMPSON TWP - BELLEVUE CSD	THOMPSON TWP - SENECA EAST LSD	TOTALS
Generators	14	3	
$1K to General Fund	$50,820	$10,890	$61,710
County General Fund	$11,538	$2,901	$14,439
Opportunity Center	$52,831	$13,286	$66,116
Bellevue CSD	$252,620		$252,620
Seneca East LSD		$53,143	$53,143
EHOVE JVSD	$27,023		$27,023
Vanguard JVSD		$2,443	$2,443
Thompson Township	$45,544	$11,453	$56,998
Health District	$1,822	$458	$2,280
Bellevue Public Library	$6,073		$6,073
Seneca East Public Library		$1,145	$1,145
Commission on Aging	$1,822	$458	$2,280
Mental Health & Recovery	$4,251	$1,069	$5,320
County Park District	$3,036	$764	$3,800
	$406,560	$87,120	$493,680

Information provided from Dalton Carr, Apex Clean Energy 4/10/18
Julie A. Adkins, Seneca County Auditor
Dated: May 11, 2018

BLOOM TWP - BUCKEYE CENTRAL
SPOWER WIND PROJECT
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75			
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL
55.92 X	$9,000	$503,280	1	$503,280	$503,280

To SENECA County General Fund				
55.92X1	55.92 MW x 1 =	55.92	County GF portion	$55,920

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	2.5836	2.5836	$13,003	$1,445	$11,558
8.70	Opportunity Center	11.8303	11.8303	$59,540	$6,616	$52,924
49.50	Buckeye Central LSD	67.3103	67.3103	$338,759	$37,640	$301,119
3.70	Pioneer JVSD	5.0313	5.0313	$25,321	$2,813	$22,508
6.40	Bloom Township	8.7027	8.7027	$43,799	$4,867	$38,933
0.30	Health District	0.4079	0.4079	$2,053	$228	$1,825
0.30	Commission on Aging	0.4079	0.4079	$2,053	$228	$1,825
0.70	Mental Health & Recovery	0.9519	0.9519	$4,791	$532	$4,258
0.50	County Park District	0.6799	0.6799	$3,422	$380	$3,042
1.54	Bloom-Scipio Jt Ambulance	2.0941	2.0941	$10,539	$1,171	$9,368
73.54		100.00		$503,280	$55,920	$447,360

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

SPOWER WIND PROJECT

BLOOM TOWNSHIP RECAP

	BLOOM TWP - BUCKEYE CENTRAL	TOTALS
Generators	1	
$1K to General Fund	$55,920	$55,920
County General Fund	$11,558	$11,558
0		
Opportunity Center	$52,924	$52,924
0		
Buckeye Central LSD	$301,119	$301,119
0		
Pioneer JVSD	$22,508	$22,508
0		
Bloom Township	$38,933	$38,933
0		
Health District	$1,825	$1,825
0		
Commission on Aging	$1,825	$1,825
0		
Mental Health & Recovery	$4,258	$4,258
0		
County Park District	$3,042	$3,042
0		
Bloom-Scipio Jt Ambulance	$9,368	$9,368
	$447,360	$447,360

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

EDEN TOWNSHIP - MOHAWK LSD
SPOWER WIND PROJECT
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75				
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL	
50.56 X	$9,000	$455,040	1	$455,040	$455,040	
To SENECA County General Fund						
1X50.56	50.56 MW x 1 =	50.56			County GF portion	$50,560

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.1799	3.1799	$14,470	$1,608	$12,862
8.70	Opportunity Center	14.5607	14.5607	$66,257	$7,362	$58,895
40.45	Mohawk LSD	67.6987	67.6987	$308,056	$34,228	$273,828
1.60	Vanguard JVSD	2.6778	2.6778	$12,185	$1,354	$10,831
4.50	Eden Township	7.5314	7.5314	$34,271	$3,808	$30,463
0.30	Health District	0.5021	0.5021	$2,285	$254	$2,031
0.80	Mohawk Library	1.3389	1.3389	$6,092	$677	$5,415
0.30	Commission on Aging	0.5021	0.5021	$2,285	$254	$2,031
0.70	Mental Health & Recovery	1.1715	1.1715	$5,331	$592	$4,739
0.50	County Park District	0.8368	0.8368	$3,808	$423	$3,385
59.75		100.00		$455,040	$50,560	$404,480

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

SPOWER WIND PROJECT
EDEN TOWNSHIP RECAP

	EDEN TOWNSHIP - MOHAWK LSD
Generators	1
$1K to Keneral Fund	$50,560
County General Fund	$12,862
Opportunity Center	$58,895
Mohawk LSD	$273,828
Vanguard JVSD	$10,831
Eden Township	$30,463
Health District	$2,031
Mohawk Library	$5,415
Commission on Aging	$2,031
Mental Health & Recovery	$4,739
County Park District	$3,385
	$404,480

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

REED TWP - SENECA EAST LSD

SPOWER WIND PROJECT

All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75				
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL	
58.99 X	$9,000	$530,910	1	$530,910	$530,910	
To SENECA County General Fund						
58.99*1	58.99 MW x 1 =		58.99		County GF portion	$58,990

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.2986	3.2986	$17,513	$1,946	$15,567
8.70	Opportunity Center	15.1042	15.1042	$80,190	$8,910	$71,280
34.80	Seneca East LSD	60.4167	60.4167	$320,756	$35,640	$285,117
1.60	Vanguard JVSD	2.7778	2.7778	$14,748	$1,639	$13,109
3.30	Reed Township	5.7292	5.7292	$30,417	$3,380	$27,037
0.30	Health District	0.5208	0.5208	$2,765	$307	$2,458
0.75	Seneca East Public Library	1.3021	1.3021	$6,913	$768	$6,145
0.30	Commission on Aging	0.5208	0.5208	$2,765	$307	$2,458
0.70	Mental Health & Recovery	1.2153	1.2153	$6,452	$717	$5,735
0.50	County Park District	0.8681	0.8681	$4,609	$512	$4,097
3.25	AVR Fire District	5.6424	5.6424	$29,956	$3,328	$26,627
1.50	AVR Jt Ambulance District	2.6042	2.6042	$13,826	$1,536	$12,290
57.60		100.00		$530,910	$58,990	$471,920

Information provided from John Moran, Project Manager Spower

Julie A. Adkins, Seneca County Auditor

Dated: May 10, 2018

SPOWER WIND PROJECT
REED TOWNSHIP RECAP

	REED TWP - SENECA EAST LSD	TOTALS
Generators	1	
$1K to General Fund	$58,990	$58,990
County General Fund	$15,567	$15,567
Opportunity Center	$71,280	$71,280
Seneca East LSD	$285,117	$285,117
Vanguard JVSD	$13,109	$13,109
Reed Township	$27,037	$27,037
Health District	$2,458	$2,458
Seneca East Public Library	$6,145	$6,145
Commission on Aging	$2,458	$2,458
Mental Health & Recovery	$5,735	$5,735
County Park District	$4,097	$4,097
AVR Fire District	$26,627	$26,627
AVR Jt Ambulance District	$12,290	$12,290
	$471,920	$471,920

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

SCIPIO TWP - SENECA EAST LSD

SPOWER WIND PROJECT

All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75					
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL		
6.9 X	$9,000	$62,100	1	$62,100	$62,100		
To SENECA County General Fund							
6.9X1	6.90 MW x 1 =		6.9		County GF portion		$6,900

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.2992	3.2992	$2,049	$228	$1,821
8.70	Opportunity Center	15.1068	15.1068	$9,381	$1,042	$8,339
34.80	Seneca East	60.4272	60.4272	$37,526	$4,168	$33,358
1.60	Vanguard JVSD	2.7783	2.7783	$1,725	$192	$1,533
6.50	Scipio Township	11.2867	11.2867	$7,009	$779	$6,230
0.30	Health District	0.5209	0.5209	$323	$36	$287
0.75	Seneca East Public Library	1.3023	1.3023	$809	$90	$719
0.30	Commission on Aging	0.5209	0.5209	$323	$36	$287
0.70	Mental Health & Recovery	1.2155	1.2155	$755	$84	$671
0.50	County Park District	0.8682	0.8682	$539	$60	$479
1.54	Bloom-Scipio Jt Amb District	2.6741	2.6741	$1,661	$185	$1,476
57.59		100.00		$62,100	$6,900	$55,200

Information provided from John Moran, Project Manager Spower

Julie A. Adkins, Seneca County Auditor

Dated: May 10, 2018

SPOWER WIND PROJECT
SCIPIO TOWNSHIP RECAP

	SCIPIO TWP - SENECA EAST LSD
Generators	1
$1K to General Fund	$6,900
County General Fund	$1,821
Opportunity Center	$8,339
Seneca East	$33,358
Vanguard JVSD	$1,533
Scipio Township	$6,230
Health District	$287
Seneca East Public Library	$719
Commission on Aging	$287
Mental Health & Recovery	$671
County Park District	$479
Bloom-Scipio Jt Amb Distric	$1,476
	$55,199

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

VENICE TWP - SENECA EAST LSD
SPOWER WIND PROJECT
All amounts are calculated on the full tax rate

Annual Service Payments		ORC 5727.75			
MW X $9,000 =			X NUMBER OF TURBINES		TOTAL
32.94 X	$9,000	$296,460	1	$296,460	$296,460

To SENECA County General Fund				
32.94X1	32.94 MW x 1 =	32.94	County GF portion	$32,940

TURBINE AND MW DATA UPDATED FOR EACH

Tax Rate			%		GF take less from entities	
1.90	County General Fund	3.2479	3.2479	$9,629	$1,070	$8,559
8.70	Opportunity Center	14.8718	14.8718	$44,089	$4,899	$39,190
34.80	Seneca East LSD	59.4872	59.4872	$176,356	$19,594	$156,762
1.60	Vanguard JVSD	2.7350	2.7350	$8,108	$901	$7,207
3.30	Venice Township	5.6410	5.6410	$16,723	$1,858	$14,865
0.30	Health District	0.5128	0.5128	$1,520	$169	$1,351
0.75	Seneca East Public Library	1.2821	1.2821	$3,801	$422	$3,379
0.30	Commission on Aging	0.5128	0.5128	$1,520	$169	$1,351
0.70	Mental Health & Recovery	1.1966	1.1966	$3,547	$394	$3,153
0.50	County Park District	0.8547	0.8547	$2,534	$282	$2,252
0.90	*Attica Venice Cemetery*	1.5385	1.5385	$4,561	$507	$4,054
3.25	AVR Fire District	5.5556	5.5556	$16,470	$1,830	$14,640
1.50	AVR Jt Ambularnce District	2.5641	2.5641	$7,602	$845	$6,757
58.50		100.00		$296,460	$32,940	$263,520

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

SPOWER WIND PROJECT
VENICE TOWNSHIP RECAP

	VENICE TWP - SENECA EAST LSD	TOTALS
Generators	1	
$1K to General Fund	$32,940	$32,940
County General Fund	$8,559	$8,559
Opportunity Center	$39,190	$39,190
Seneca East LSD	$156,762	$156,762
Vanguard JVSD	$7,207	$7,207
Venice Township	$14,865	$14,865
Health District	$1,351	$1,351
Seneca East Public Library	$3,379	$3,379
Commission on Aging	$1,351	$1,351
Mental Health & Recovery	$3,153	$3,153
County Park District	$2,252	$2,252
Attica Venice Cemetery	$4,054	$4,054
AVR Fire District	$14,640	$14,640
AVR Jt Ambularnce District	$6,757	$6,757
	$263,520	$263,520

Information provided from John Moran, Project Manager Spower
Julie A. Adkins, Seneca County Auditor
Dated: May 10, 2018

17-2295-EL-BGN

Republic Wind
Public Hearing Testimony

September 12, 2019

My name is Jennine Kramer and I am a lifelong resident of Seneca County. I lived in rural Seneca County for the first 32 years of my life and in the City of Tiffin for the last 27 years. I recently retired after a 37 year career in education. The first 5 of those years were as a music educator and the last 32 have been teaching children with developmental delays with the majority of my students on the autism spectrum. Though I could give you a long list of why Seneca County is not a good fit for wind turbines, I am going to stick to my area of expertise, the autism population.

Fifty years ago my little sister, Kelly, was born and it was almost immediately known that she had Down's Syndrome. What we didn't know at the time was that her primary disability was autism. I had never even heard of autism until many years later so as she was growing up I had no idea that the issues she was dealing with were actually sensory issues. I remember the days of trying to take her through a mall and having to carry her with her head buried into my chest and her ears covered, trying to take her to sporting events which would totally overwhelm her, attending the circus as a student which would become a traumatic experience, the number of times I felt her trembling in my arms and at the time not knowing what she was actually experiencing was severe sensory issues from environmental input that I didn't even realize existed.

In 2018 the CDC (Centers for Disease Control) determined that approximately 1 in 59 children is diagnosed with an autism spectrum disorder (ASD). Sensory issues and noise sensitivity have always been a part of the experience of autism (which includes Asperger syndrome), but only became a recognized part of the diagnosis with the fifth edition of the Diagnostic and Statistical Manual (DSM) of the American Psychiatric Association in 2013. The DSM-5 identifies "hyper- or hypo-reactivity to sensory input or unusual interests in sensory aspects of the environment" including indifference, sensory-seeking and adverse responses to specific sounds, textures, smells and lights or movement. People with autism can be both over-sensitive (hyper) and under-sensitive (hypo), as well as either seeking out or avoiding sensory stimulation.

Children who experience noise as an unpleasant sensation, or even as physical pain, develop defensive reactions (such as covering their ears) and avoidant reactions (seeking only activities and places without excessive noise). People with autism frequently mention a dislike of percussive sounds, changing or unexpected sounds and specific, intense frequencies, such as strip-lighting and the hum from computer fans and refrigerators.

I come before you today to beg you to protect my sister, my grandchildren, my entire family, my former students, the entire autism population and my community. I have lived my life supporting and advocating for individuals with autism. I have watched children literally bang their heads wide open, bite their hands until they bleed, become extremely physically aggressive, retreat into isolation in an attempt to block everything out and many more extremely negative reactions to sensory input. Often it is difficult to figure out what the triggers are and until you do, and if you do, the negative impact it has on the children is horrendous. As a teacher we worked to teach them coping skills and to try and desensitize the intense effects of the input they are receiving. Though you may have success with this, the frequency and duration of the exposure is often very limited.

How anyone could have not done their homework to understand these effects on this population and propose we erect wind turbines outside of their homes, is beyond me. In my career, I was a mandated reporter when it came to any knowledge of neglect and abuse. Well, I am reporting to you today that this is neglect and abuse to anyone who will experience adverse effects from anything connected to the wind turbines including, light flicker, flashing lights, infrasound, etc. I will hold anyone who promotes and approves the wind turbines personally responsible for any health effects experienced by these individuals. From my experience and expertise in this field I can stand here and tell you, it is not a question as to whether there will be any negative effects, it is a question of how many and how severe the effects will be, making the approval of the wind turbines both neglectful and abusive.

I would like to thank you now for stopping this catastrophe from happening and keeping Seneca County a safe and healthy place to live.

Jennine Kramer
Tiffin, OH

17-2295-EL-BGN

9/12/19

I am against the Apex Republic Wind project because;

1.The severe possible health issues related to ITWs.

2.The loss of safe air space for Life Flight to land, which could potentially cause delayed time getting accident victims to a larger hospital, possibly even deaths.

3.The loss in value of our beautiful scenic landscape in Seneca County by 600+ feet Industrial Wind Turbines is far beyond any monies made by only a few land owners.

4.100+ persons per square mile is too populated an area to place these monstrous turbines.

Linda Hetzel

Linda Hetzel

Eden Township
Seneca County
Tiffin OH

REINEKE REFERENDUM
We all deserve a voice!
~WIND~ PROJECT

17-2295-EL-BGN

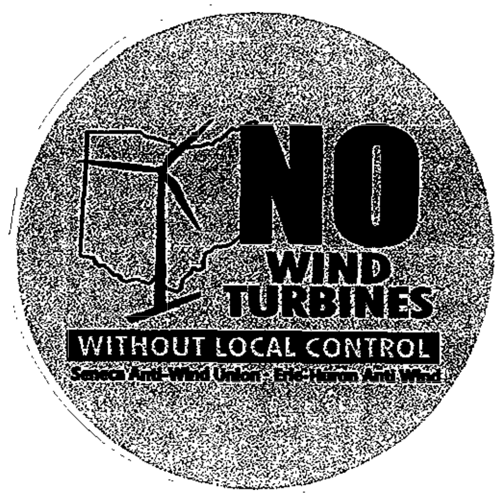
9/12/19

I am against Apex Republic Wind project for many reasons. Including, but not limited to, the health issues the Industrial Wind Turbines cause, loss in land values, and the stress placed on the many people in the area that will receive no financial compensation.

Ken Hetzel

Ken Hetzel

Eden Township
Seneca County
Tiffin OH



17-2295-EL-BGN

Jame Colvin Sr.
2936 Co. rd. 276
York twp
Sandusky County

My name is James Colvin Sr.

I own property in Sandusky County that will be adjacent to the Turbines purposed by Republic Wind.

I truly feel nothing I say or write will influence or have an impact on this project. I feel the OPSB is put in place to expedite these project, not deny them.

The testimony you will hear today you've heard before. The testimony for the project will come frome those who will profit from it, while testimony against the project will show negitive effects such as, property devaluation, health effects, devestation of wildlife, misuse of farm land (will never again produce a crop).

I hope the siting board will listen to those testifing today and not be playing on their cell-phones the way they did during the Seneca Wind hearing. That was very disrespectful!!

I want it to be very clear that I oppose this project and any further wind projects

Thank You James Colvin Sr.

17-2295-EL-BGN

Sherry ~~Rieck~~ Riech

Sherry Riech - from Tiffin Ohio
I love the Turbines - They are beautiful - most places do! But Seneca Co. has this bully that started all these Rumors! And has all these followers
Alot of Supporters have been the "Minions" bullied! Land owners have had there yards torn up - bc they had yard Signs
I been harassed in the Grocery Store ~~[illegible]~~ buy these minions first HAND.
All these Rumor Started by this Head MINION - you should be ashamed of yourself! Get the facts
The wait is due to the minions repeating false accusations
Reed Town

Rumor
the Foundation of these Turbines are not deep enough to impact our ground water
Turbines are sighted away from Wells other water sources
Its regulated by the State

Pestisides destroy our Well water!

Water - Lakes Polluted by the Davis Besse
Power Plants Radiation
old - Costly unrepairable
effects our food/water
Not safe 4 air!

We are old - what about our Grand Kids - Kids future!

Rumor 2 Light Flicker
1 Driving Down
wind - trees

Rumor 3 Birds - Love Birds
Cat do too!
windows don't move
airplane - move fast

OTTO BON-
Support wind power as a renewable Energy source that reduces threats to birds by Climate change

Trees
Cell phone towers
Life flight pilots very skilled

Thank - You for having mey support of Republic Wind

Look forward to the turbines

17-2295-EL-BGN

MARY
MUSKO

Members of the Ohio Power Siting Board-

I have been approached by a natural gas company and an oil company to sign contracts, but I never did because I do not want to ruin the land and I don't think it would be good for my farm.

A wind farm does not damage farmland and is a renewable source of energy that improves the air quality and keeps water clean, unlike other energy sources, which emit harmful pollutants.

Wind farms offer an opportunity for farmers to diversify their income especially when the weather doesn't cooperate, like this year. A continuous payment would help with living expenses and the costs of farming.

Republic Wind will also provide $54 million in payments to the county, city and schools. This money can help build new roads and provide additional funding for our local schools. I see this as a win/win situation for the community.

Thank you for taking the time to hear my support of the Republic Wind Project.

17-2295-EL-BGN

SEPTEMBER 12, 2019

I AM HERE TO SUPPORT THE REPUBLIC WIND PROJECT.

MUCH OF THE ANTI-WIND TURBINE RHETORIC USES FEAR INSTEAD OF FACTS TO FURTHER THEIR CAUSE. HERE ARE SOME FACTS REGARDING A FEW OF THEIR TALKING POINTS.

BIRD KILL: FAR MORE BIRDS ARE KILLED BY CATS, VEHICLES, CELL TOWERS, POWER LINES, WINDOW/BUILDING STRIKES, ETC. THAN BY WIND TURBINES.

INFRASOUND: MANY HOUSEHOLD APPLIANCES PRODUCE INFRASOUND; REFRIGERATORS, AIR CONDITIONING UNITS, FANS, ETC. WAVES ARE PROBABLY THE LARGEST SOURCE OF INFRASOUND, YET MANY PEOPLE WILLINGLY CHOOSE TO LIVE CLOSE TO LAKES AND OCEANS.

SHADOW FLICKER: CAREFUL POSITIONING OF WIND TURBINES GREATLY REDUCES OR ELIMINATES ANY POTENTIAL FOR SHADOWING.

DANGER FROM ICE THROW: MANDATORY SETBACKS AND POSITIONING WILL ELIMINATE THIS POSSIBILITY. OHIO HAS SOME OF THE MOST RESTRICTIVE SETBACKS.

IN CONCLUSION, I HOPE YOU WILL CAREFULLY CONSIDER THE POSITIVE ASPECTS OF WIND ENERGY: RELIABLE, CLEAN, AND RENEWABLE. THE REVENUE GENERATED WILL BENEFIT OUR SCHOOLS, COUNTY AND TOWNSHIPS.

THANK YOU FOR YOUR CONSIDERATION.

Kathryn L. Walters

KATHRYN L. WALTERS
6556 N. STATE RTE. 18
CLYDE, OHIO 43410
SENECA COUNTY
THOMPSON TOWNSHIP

17-2295-EL-BGN

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PROJECT

Republic Wind Case # 17-2295-EL-BGN

Christina Popa
3336 Willoughby Rd
Willard, Ohio 44890

I live in Huron County but I come to the Sorrowful Mother Shrine several times a year. The Sorrowful Mother Shrine is located at 4106 Ohio 269 in Thompson Township in Bellevue, Ohio. The shrine, like many residences, will be in the cumulative view shed of the multiple wind farms being proposed for Seneca, Erie and Huron counties.

Per the Catholic Travel Guide the Sorrowful Mother Shrine is the oldest place of pilgrimage dedicated to the Blessed Mother in the Midwest and east of the Mississippi. This historic shrine, established in 1850, consist of 120 wooded acres. There is an open air Pieta chapel and an indoor chapel. The walkways on the grounds lead to the Stations of the Cross, shrines and grottos. There is also a pilgrimage center and a gift shop. According to the Ohio Traveler.com the shrine has "all of the beauty of nature in a peaceful atmosphere".

The shrine has personal and group pilgrimages throughout the year. Pilgrims from catholic ethnic communities have come from Toledo Cleveland, Columbus, Youngstown and other places. There are scheduled masses during the week and on weekends.

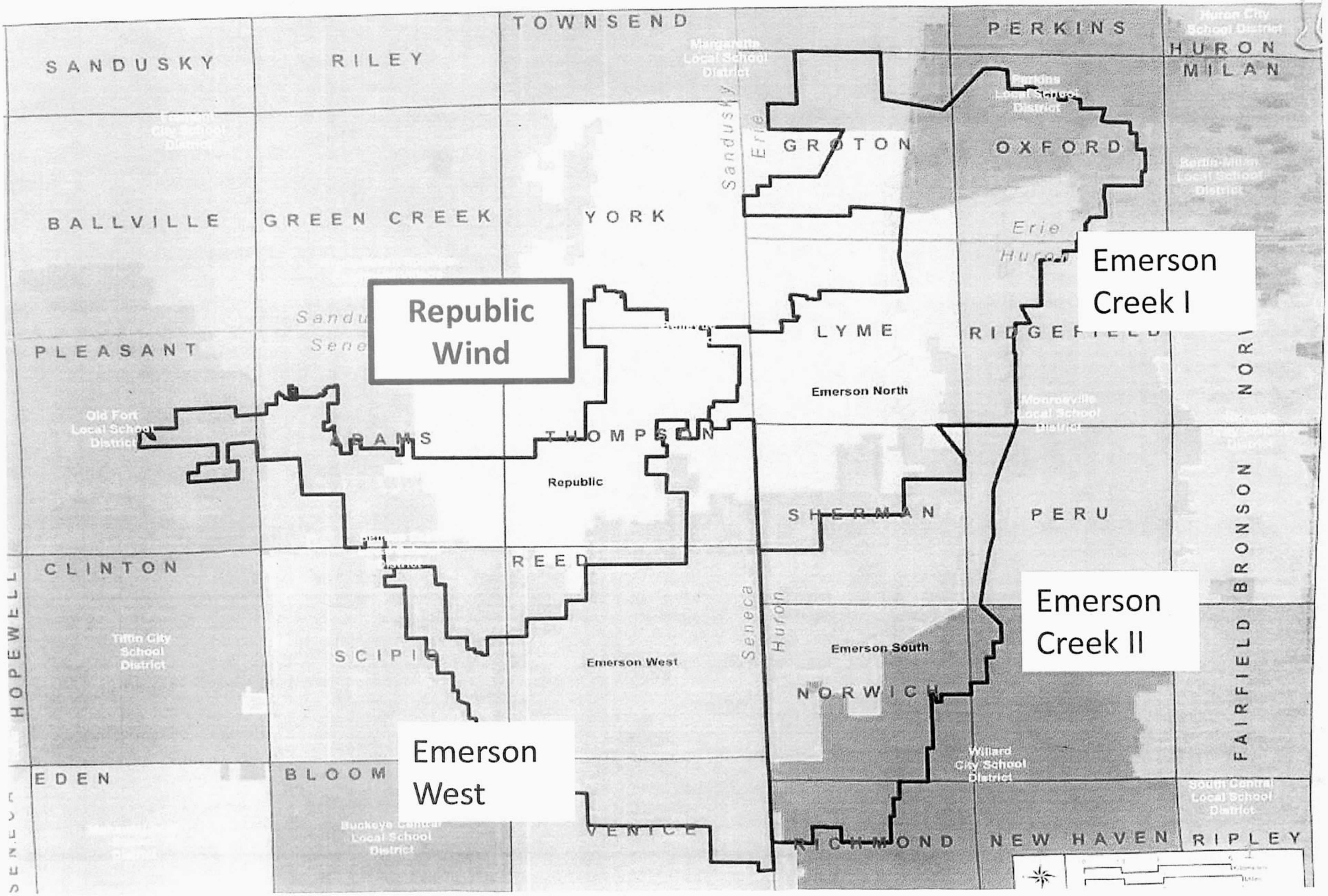
According to Ohio's Lake Erie Shores and Islands "The Shrine provides a peaceful place to reflect for people of all faiths". People, couples and families come here for mass, to reflect and pray, and to experience the tranquility of being in nature. People come in the summer to attend the outdoor masses.

Apex has more than just the Republic Wind Project planned for this area. Emerson Creek is being proposed for Huron and Erie County. This would include Lyme and Sherman Townships which are adjacent to Thompson Township. Another industrial Wind farm is Emerson West which I understand would be in Seneca County. S Power recently withdrew the application for Seneca Wind in Seneca County but can resubmit their application.

The combination of all of these proposed industrial wind farms, with the hundreds of turbines which would be seen, has the potential to negatively impact the Sorrowful Mother Shrine. People come here to experience the silence and beauty of the outdoors. One online review I read was the shrine is a "great place for prayer and meditation". I would like to see it stay that way.

I ask you to say no to the Republic Wind Project.

FOUR APEX Projects: Republic Wind, Emerson Creek Wind I and II? and Emerson West Wind

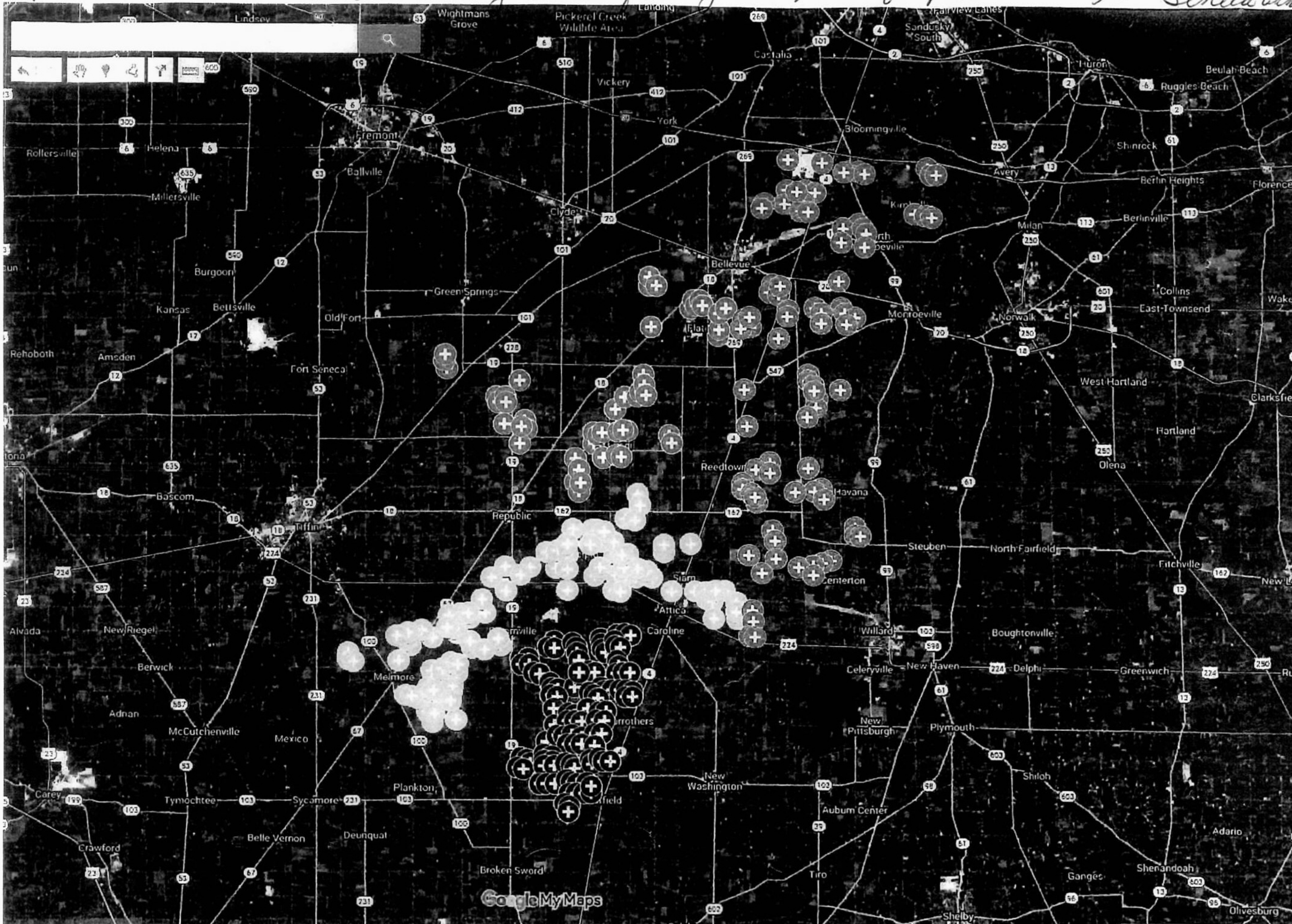


Christina Popa
3336 Willoughby Rd
Willard, Oh 44890

Republic Wind — 17-2295-EL-BGN

Emerson Creek — 18-1607-EL-BGN

☆ Emerson West - Seneca County (west of County line, South of Republic Wind) (overlaps c̄ Seneca Wind)



Blue - Emerson Creek   Red - Republic Wind   Yellow - Seneca Wind   Burgundy - Honey Creek

Christina Popa
3336 Willoughby Rd
Willard Oh
44890

Republic Wind — 17-2295-EL-BGN

Emerson Creek — 18-1607-EL BGN

17-2295-EL-BGN

Nathan Root

My Name is Nathan Root, I live in Seneca County on a 100 acre farm just outside of Flat Rock. For the record, Our farm is not scheduled to have a wind generator on the property.

When I first became aware of the possibility of Wind Generators in our area, I did some preliminary research and soon discovered just how much information was out there. Information that is either mis-leading, an exaggeration of facts or just plain untrue. Over the years I've done my share of Marketing and Advertising so I am well aware of the art of "word smithing" to convince others of your beliefs.

So, to clear the muddy waters for me to make a decision....throwing away the stories of birds being eliminated from the sky, the schools duped out of monies, people going mad from the noise or that property values will plummet,...

I narrowed my focus to two issues.

We have to make an immediate and concerted effort in reducing the use of fossil fuels.

And the other issue is:

The erection and operation of Wind generators will forever change my view of the landscape when I either look out my window or travel down the road.

This issue and this issue alone I believe is the Genesis for folks not wanting the Wind Generators. But arguing AGAINST a viable form of energy to reduce our dependence on fossil fuels for the mere fact of "my views of the landscape will change" sounds a bit selfish..... and trying to make an argument against an issue purely on the basis of selfishness makes it a little more difficult to find supporters. So we resort to slightly skewed facts to either scare, bully or intimidate the opposition to siding with our beliefs.

I have four grandkids who are depending on me not to be selfish and to ensure they have a bright future.

THEY are why I am for the Republic Wind program.

Thank you

17-2295-EL-BGN

Wind development in Seneca County will bring much needed support to our public schools, roads and public safety. This project will be a source of long term revenue for those entities. This means $36 million dollars for our local schools, $18 million dollars for the county and townships along with $29 million dollars to the participating land owners. These are dollars that will ~~in turn~~ be spent in the local economy. We need to support this project for the future benefit of Seneca County.

Thomas Buffington
305 E. Tiffin St
Attica, OH

17-2295-EL-BGN

ALBERT MEYERS

Thank you Ohio Power Siting Board for hearing my Support of the Republic Wind project today. As someone who has lived in Republic my whole life, it matters to me that this community has the opportunity to Flourish. This County and Townships will receive $18 million in payments. In particular the local Schools will benefit from an additional 36 million.

When I was driving by the wind farm near Dunkirk, I stopped by a house near the

Albert Meyers

wind turbines to talk to
the man that lived there.
He wasn't a project participant
and told me that he used to
be opposed before the project
was built. He heard misinformation
from wind opponents and thought
property values would decrease
they did not. He told me that
he hasn't had any problems.
with the wind Farm and
now supports it. Please do
not let fear and misinformation
decide the fate of this project.
Please approve Republic Wind

Albert Meyers   Thank you

Proposed Republic Wind Farm Opposition Testimony

Republic Wind, LLC, OPSB# 17-2295-EL-BGN

Keith Moyer

My name is Keith Moyer. I live at 3040 South State Route 67, Tiffin, Ohio, which is in the northwest corner of Bloom Township, and have resided there since 1981. My home is within the 10 mile visual study area of the proposed Republic Wind Farm.

I would like to focus on the visual impact assessment as submitted by Republic Wind, LLC and prepared by EDR, (Environmental Design and Research, Landscape Architecture, Engineering, and Environmental Services).

According to Ohio Administrative Code 4906-4-09, (C) (6) "The applicant shall provide photographic simulations or artist's pictorial sketches of the proposed facility from at least one vantage point in each area of three square miles within the project area, showing views to the north, south, east, and west. The photographic simulations or artist's pictorial sketches shall incorporate the environmental and atmospheric conditions under which the facility would be **most** visible."

The assessment submitted 96 viewpoints. Of the 96 submitted photographic viewpoints, 9 were selected for visual simulation. Of those 9 viewpoints only **5** were within the project area. **None** of these 5 simulations included 4 angles of observation. There were no submitted simulations in the project area which incorporated views to the north, south, east, and west. **None** of the photographic simulations met the requirements of all four compass directions.

Ohio Administrative Code 4906-4-08 (D) (4) Impact of the facility, Section (a) states; "Describe the visibility of the project, including a viewshed analysis and area of visual effect shown on a corresponding map of the study area. The viewshed analysis shall **not** incorporate deciduous vegetation, agricultural crops, or other seasonal land cover as viewing obstacles."

All of the observation point photos were taken in July, when the area trees were in full leaf and crops were well-developed in the fields. Therefore this viewshed analysis submission **did** incorporate deciduous vegetation, agricultural crops and other seasonal land cover as viewing obstacles and it does **not** fulfill the Ohio Administrative Code.

Having driven thru areas in Ohio that contain wind farms with wind turbines that are much shorter than those proposed for the Republic Wind Farm, I can state that this study does **not** show the visual impact of 47, over 600 foot tall wind turbines in 6 townships. Technically, since the total elevation change in the project area is only 255 feet, which is less than half the height of the proposed over 600 foot tall turbines, most of the turbines would be visible from any unobstructed view in the project area.

If the intention was to actually show the visual impact of the wind turbines, they failed, and their application for a certificate should be denied.

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PROJECT

Seneca County Ohio 9/12/19

Ed Clark

All,

I have a question that keeps coming back up, and I can't really get any real answer to this. Who sets the rules and guidelines for the construction of the industrial wind turbines? The best answer I have received is from the AWE and it is a basic answer that really puts it back on the engineer who works for the wind companies. It is the standards that the engineering company put forth and this is how they come up with guidelines. It seems as the wind industry sets the standards for themselves, they use their own reports on noise, shadow flicker and infrasound and will not take any private sources findings in consideration. Where are the independent studies from W.H.O. along with that studies from Canada, along with other reports of well contamination? Michigan just published that they are seeing infrasound as a problem with their rural residents.

Everything we see is making the communities & residents to bear the burden of proof the problems that are caused by the wind projects once these projects at completed. From anything that I have read, wind turbines are not required to have any lighting protection as an industry standard. I have read where even if there is lighting protection that it will not pick up on **incidental lighting strikes**. This type of strike cannot be detected and go unnoticed as damage to the blades would pass a ground inspection. This would lead to contamination of water to the blades and the cold weather climate could cause blade failure. This would be just cause to move them further back from homes or general population.

There is no required inspections from the state of Ohio on the installation of the underground structure, direct buried 34kV lines, or grounding of the structure. There are no standards for protecting the general public from toxic fumes if the turbine catches fire. Employees are required to maintain 1600 plus feet due to asphyxiation from the smoke, but we the citizens must be expendable as Ohio says a minimum of 1330 feet. In the case of Van Wert Ohio less than a 1000 feet. I did like it when the wind companies addressed this in the PUCO public hearing. The comment was we do not want to go down this road of inspections as it will impact their process in getting projects completed. My thought is, what is wrong with looking out for the public's safety? By doing phase construction inspections, as every other contractor must comply with, this insures that the public's safety is being look at and insuring that we do not have problems.

In the matter of grounding and securing the area around these power plants, all the grounding that I have found is based off of a mountain type area where you have more surface contact to the concrete base, but even then rocks are not the best as if you look at MSAW (Mine Safety & Health Administration) there still is all types of methods you need to do in order to get the minimum ohms to ground readings. The AWE comments in the findings that they should have less than half due to the power production and the higher possibility of a lighting strike. Here again, we are letting the industry to self-police these projects. In the case of Wal-Mart and Tesla with the solar panels catching fire, the findings was the grounding was not installed properly and the grounding of the panels is what caused the fire.

Let's take a brief look at look at the deaths from electrocution. Although farmers are one of the lower number of direct contact with medium voltage lines with equipment, we are now going through the fields with 34,000 volt lines and will increase the possibility. What is the depth requirement for a medium voltage line? 24-inches is what is required by the NEC to the top of the conductor. I would think that this is based off using the normal circumstance where we see direct buried lines in right ways in town. Anything less shall be in conduit and or concrete encased. By installing these cables at the 24 inch mark will increases the possibility of them being killed by striking these lines. Farmers use a tool for the compaction of their soil. It has the possibility to reach 22-inches deep. Let's just say that the cables were buried at 24-inches and when completing the project the ground cover gets move to a lesser depth of 24-inches, who is going to insure that the farmer will not make contact with this type of tool? Are we going to tell the farmer that they can no longer use this area? Is the wind company going to control the area for usage? In the electrical contractor's world, our engineers normally requires us on a 7,400 volt lines to be at 36-inches and encased. I would think the PUCO/OPBS would require deeper installation of 34,000 volt lines that are not protected going across farm land.

I see that the PUCO is now rewriting the guidelines for natural gas pipelines. And is this because of other problems that have come to light with the recent pipelines being installed throughout the state?

Is this where we are going to be with the wind projects in Ohio? Trying to fix problems that we already know are problems? There is so many questions that need to be answered with the wind projects we are faced with right now. I'm not sure if you have ever read any land owners contract before or not, but in one section it says just the first just the first three feet of the base to be removed below grade. What happens to the rest of the 500 – 700 yards of cement? And who is going to deal with it? If TOPO or Topography was never done, what prevents them from covering them up and changing the grade? Here again no records and no reporting of what the grade is at the start. This will affect the watershed of the property and field drainage. Who will remember what it was? On any commercial project TOPO has to be done to ensure that watershed will not to affect any of the surrounding properties. We have seen this in the pipeline in Seneca County where one of the owners had the TOPO done out of his own pocket, and they held the contractor doing the work responsible to put the ground back the way it was. This took the contractor a year to get it right.

If this was a typical power plant that is owned by an AEP, Duke Energy or Ohio Edison it would be policy that the projects be required to follow building standards, but instead we look at these projects like we are installing power poles. If we were to install 100 foot wind turbine for our own homes, it would fall under more inspections and general safety rules for my neighbors than these 600 – 700 foot tall turbines. Setbacks should increase not decrease and we the citizens of the affected areas should have the final say on these projects, after all we will be the ones living here, and not some construction company from Canada or West Texas and surely not any of the people from the wind companies that are sitting in this room. The PUCO is to protect ***us*** the citizens of Ohio from these type of projects and any future problems.

If I am wrong on the process, please tell me where I can go to find the guidelines that the State of Ohio put forth for the wind companies to follow. As of today I cannot find any federal and or state written laws on the construction requirements. Even the lawyers for the wind companies made the statement to the PUCO that they do not want to be bound by inspections as they feel it will impede the process of construction. Safety MUST be the first and up most important thing before any and all construction of these power plants that are being installed around our state.

In closing I feel the OPSB should not grant the Republic Wind project a permit due to multiple reasons.

1. It is the OPSB responsibility to keep all the citizens safe in regards to these type of projects.

2. Karst – with these type of depressions in the region, there is no responsible way to install the bases for the turbines without a negative outcome to wells, and roadways. The land will not support this type of heavy loads or structures without deep foundations or tensionless pier foundation.

3. Wells – protection of well water should be of the up most importance. I have had numerous phone conversations with the EPA and the State health department, but no one wants to be responsible for any possible negative outcome, like we have seen in Canada.

4. Wild Life – this is a migratory path for all types of birds, bats and protected birds of prey, Eagles Red-tailed Hawks. This past week we have seen a high migration of grasshoppers and monarch butterflies along with others. Maybe to some it sounds stupid, but it is part of our eco system, and needs to be protected.

5. Infrasound – One of the hot topics that the wind industry denies as true facts. We have seen reports from WHO, and now other states like Michigan, pushing back and passing laws about infrasound. Our own U.S. State Department officials contended Cuba staged a sonic attack on employees of the American embassy, causing a variety of neurological symptoms. Both sides acknowledge they are baffled as to what happened to 24 embassy employees who were diagnosed with mild traumatic brain damage between November 2016 and August 2017.

With just these reasons, it should be enough to stop the project and make the PUCO look at how we are treating the citizens of Ohio. Remember, at one time we all thought smoking was safe, cocaine was a wonder drug, heroin was a cure for a cough and asbestos was safe.

Sincerely

Ed Clark / Eden Township Seneca County, Ohio
Ethog3@gmail.co
419-618-0031

30 MILES OF DEFLECTION

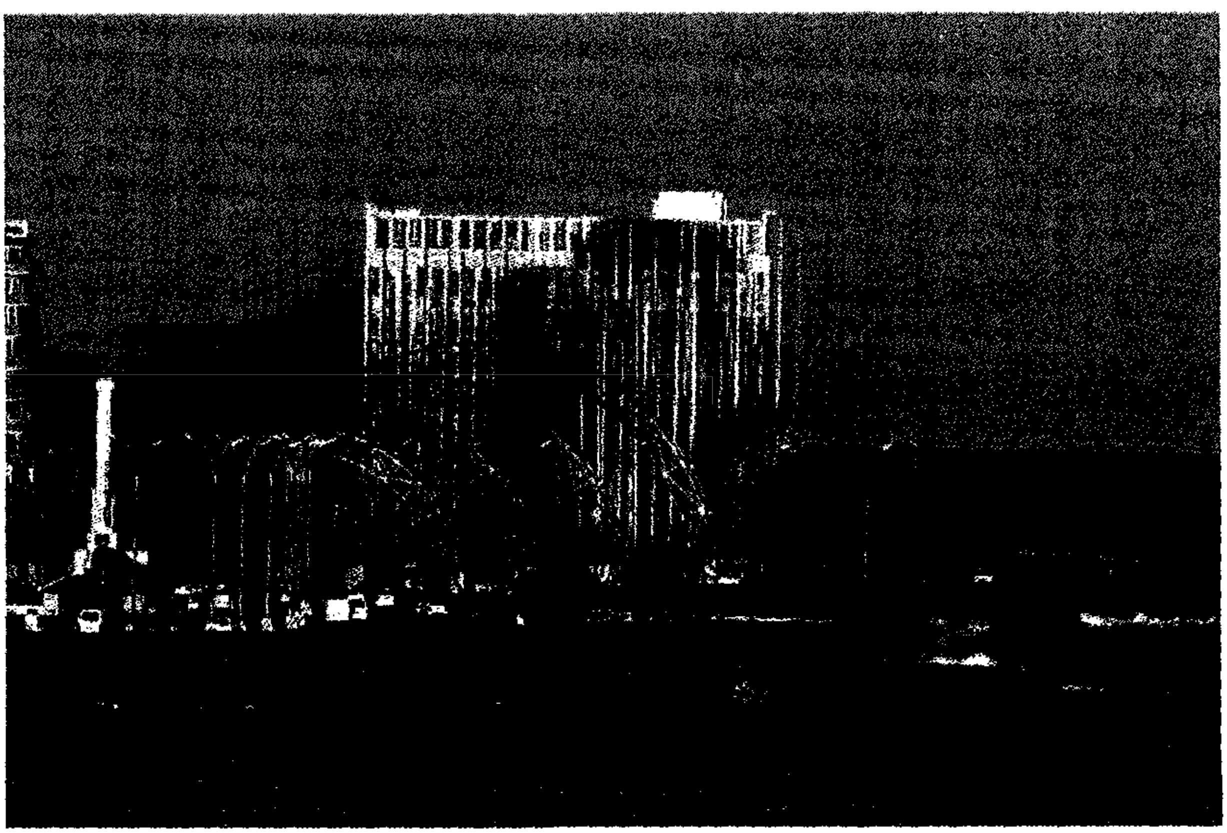
NOAA Weather Radio - KHB97 162.400 MHz

POLICY & ETHICS

"Sonic Weapon Attacks" on U.S. Embassy Don't Add Up—for Anyone

Cuban scientists and a new American report both shoot down a list of bizarre theories

By R. Douglas Fields on February 16, 2018



One unproved theory holds that an array of poles and metal awnings in a park adjacent to the U.S. embassy in Havana serves as a system of antennas that are part of a sonic or microwave weapon. Called *El Monte de las Banderas* (the Mount of Flags), the poles were erected countries that bracket the Strait of Florida. U.S. State Department officials contended Cuba staged a sonic attack on employees of the American embassy, causing a variety of neurological symptoms. Cuba has not only denied such an attack ever took place but has also emphasized the physical impossibility of a sound wave causing neurological damage trained on such a distant target.

But physicians and scientists from both countries now appear to be in agreement on one critical point: Both sides acknowledge they are baffled as to what happened to 24 embassy employees who were diagnosed with mild traumatic brain damage between November 2016 and August 2017.

The latest development is a preliminary publication in *JAMA The Journal of the American Medical Association* on Thursday, authored by the team of doctors at the University of Pennsylvania who examined 21 of the U.S. government employees. The study, commissioned by the federal government, found the patients had suffered from concussionlike symptoms—but without any blunt trauma to the head. The medical issues varied widely among the patients, and included cognitive difficulties and problems with balance, eye tracking, sleep disturbances and headache.

Adding yet another element to the mystery, the new findings show normal MRI brain scans in all patients, and normal hearing in all but three individuals. The authors of the *JAMA* study also discount the likelihood of sonic injury, infection or toxic agents —and they even downplay the frequent suggestion of mass hysteria. Many of the findings in the new report echo a previous investigation carried out by Cuban officials.

The new report's inconclusiveness does little to break the impasse. The State Department has issued multiple warnings in recent months that U.S. citizens should not travel to Cuba, because numerous embassy employees here had been targeted in attacks. The culprit was thought to be some form of unidentified sonic weapon trained on embassy employees, primarily in their residences near the post, including at the Capri Hotel.

The precise mechanism of the alleged attacks remains unclear. Between November 2016 and August 2017, some embassy staff complained of hearing strange sounds that targeted specific individuals—one person would hear them and another in the same world." Without knowing more about the causes of the incidents, Todd Brown, now-acting assistant director for international programs at the State Department's Bureau of Diplomatic Security, testified he could not assure the safety of diplomats coming to Cuba.

The Cuban Neurosciences Center in Havana carried out an investigation of the alleged sonic attacks.
Credit: R. Douglas Fields

Throughout the series of alleged attacks, however, questions have persisted as to how any sonic weapon could, without deafening levels of noise, have produced hearing loss and cognitive symptoms. In an attempt to address these questions, the Cuban government formed a technical committee of officials and academics to investigate the incidents; a report was issued late last year. At the Cuban Neurosciences Center, a towering concrete building situated near President Raul Castro's heavily guarded estate well outside the tourist area, Mitchell Valdés-Sosa, general director of the center and an expert in auditory physiology who served on the technical committee, reviewed the report with me in late December.

The authors—a team of scientists including neuroscientists, physicians and physicists, among others—examined the available medical reports on afflicted embassy employees. The scientists and criminal investigators set up sound and radio-buildings in the surrounding areas for unusual equipment, and searched customs records for evidence of any sound-emitting equipment brought into the country. On the basis of these data the committee found all the proposed explanations for the alleged sonic attack implausible and, in many cases, contrary to the laws of physics. The report addressed a number of hypotheses, listed below, for the alleged attack. Valdés-Sosa explained why the committee had dismissed them all:

Audible sound—A blast of sound loud enough to damage hearing, Valdés-Sosa says, would have been obvious to anyone near the embassy, and the source could not selectively target different individuals in the same room. No loud sounds were reported by witnesses or nearby residents, and none were detected by surveillance equipment. Physicists on the committee found even deafening sounds beamed into the buildings would be diminished by the walls and windows to a level well below that required to cause hearing loss.

Cell phone recordings of the alleged sonic attack were provided to an Associated Press reporter by an anonymous source in the State Department. But the sounds were identified by Yamile González Sánchez, an official at the Ministry of Public Health, and physicist Carlos Barceló Pérez, a professor at the National Institute of Hygiene, as those made by local insects, which they recorded on the scene. Moreover, the sounds, all in the audible range (about 7 kilohertz), would have overdriven the microphone—

Audiograms (tests of hearing sensitivity) would have been useful in pinpointing the precise sound used in a sonic attack, because loud noise inflicts hearing loss at the specific frequency of the damaging sound. But despite requests from the committee, the U.S. declined to provide them. Hearing tests of residents in the surrounding area, made by audiologist Alida Suárez Landrián, found no abnormalities.

Many embassy staff members have returned to the U.S. after reports of strange high-pitched sounds and 24 employees being diagnosed with mild traumatic brain injury. Credit: R. Douglas Fields

Sound outside the range of human hearing—The physics of sound propagation

Infection and intoxication—Antibiotics and antimicrobial drugs can produce hearing damage. But Valdés-Sosa says the investigation could find no plausible way for such an agent to be administered selectively to people of such different ages who were affected in different places and times. The attacks are alleged to have occurred on multiple occasions between November 2016 and August 2017.

The Caribbean Basin is home to many viral infections—dengue, chikungunya, Zika—but none have produced this constellation of symptoms. Indeed, Charles Rosenfarb, medical director of the State Department's Bureau of Medical Services, describes the wide-ranging symptoms as a "novel syndrome" never seen before.

The investigation was hampered by the cursory information provided to the Cubans by the U.S., Valdés-Sosa says. Rather than detailed medical records, the committee said it only received a single-page summary of complaints reported by embassy employees and family members—a list that included hearing loss, vertigo, tinnitus, memory problems, difficulty concentrating and visual disturbances. "If we had the medical records, maybe we could exclude [a toxic agent], but this hypothesis seems also unlikely," Valdés-Sosa says. The committee said its request to interview and examine victims was denied.

Peculiar structure outside the embassy—An array of metal poles and awnings in a park outside the embassy, also in a direct line of sight with the Capri Hotel, was thought to be a possible antenna system for a sonic or microwave weapon. But the structures are simply flag poles erected to obscure an electronic sign on the embassy that formerly flashed information objectionable to Cuban authorities. If it had served as a sonic weapon, "it would affect everyone in the building," Valdés-Sosa adds.

White matter damage— After the Cuban report was released, the Associated Press reported that magnetic resonance imaging scans by physicians at the University of Miami and Penn showed damage to white matter in the brains of embassy employees, and that this information would be published in a paper submitted to the *Journal of the American Medical Association* (JAMA). White matter is brain tissue comprised of bundles of cables (myelinated axons) that connect neurons (gray matter) to form circuits. But experts quoted in the AP article stated that sound does not damage white matter. Such damage would require violent concussive forces, something I learned in my own laboratory research on blast injury and myelin. The lead author of the investigation finding white matter damage in embassy employees was identified by the *Miami Herald* as Michael Hoffer, a University of Miami ear, nose and throat specialist and former U.S. Marine physician. Hoffer referred my inquires to the University of Miami Press Office, which declined comment, unable even to clarify whether a manuscript showing white matter injury in the U.S. diplomats had been submitted for publication. At this point, no medical evidence of white matter damage is known to have been reported.

The position of U.S. officials on the issue is still unclear. Officials at the State

Mitchell Valdés-Sosa, at the Cuban Neurosciences Center in Havana, reads a summary of the investigation into alleged sonic attacks. He is the center's chief executive, an expert in auditory physiology and a member of the committee that investigated the alleged attacks. Credit: R. Douglas Fields

"This is part of the same pattern," Valdés-Sosa says. "Something is leaked to the press, but in such a vague way you can't confirm it or de-confirm it." He also wants to know why data in the report had not been shared with the Cubans. "If there was any evidence of a real attack by anybody," he says, "the Cuban government would react strongly—and as a scientist I would be very worried. I think the word would have to be spread so people could protect themselves."

reports made by patients and thus lacked the types of procedures brought to bear in a formal scientific study—it was not known, for instance, what the neurological status of the diagnosed patients was before they became ill. Many of the tests were only given to a small subgroup of patients. Just six patients received cognitive and neuropsychological tests. From a medical perspective, Muth and Lewis noted the range of symptoms is shared by many different medical illnesses apart from concussion.

Those concerns were echoed by Valdés-Sosa in an e-mail after reading the report: "The study has serious limitations," he wrote, but he was more disturbed by how this information was released. "The most alarming consideration is that medical data was withheld from the Cuban side to protect the patient privacy, but then it goes directly to publication," he added. The Cuban scientists never questioned that these individuals experienced a range of health issues, he noted, but this new information does not clarify the cause or causes; indeed, it complicates matters. "The argument for a 'new syndrome,' or even of a 'health attack,' is very weak." He added: "The objective findings [for example, abnormal audiograms] are present in only very few of the cases, and are inconsistent. It is not possible to know if any of the results are due to preexisting diseases or if their prevalence is larger than expected for any group of persons of the same age. The published conclusion that all the diplomats 'sustained injury to widespread brain networks' was not demonstrated by the data presented."

Some U.S. officials have suggested various theories for what might have happened. Rubio and others have suggested a rogue faction in Cuba could be responsible for the attacks. "People who think a rogue faction in Cuba is responsible do not know Cuba," Valdés-Sosa says. "There is no rogue faction in Cuba." In Cuba, often described as a employees with military experience, Valdés-Sosa suggests, may have been exposed to loud blasts causing mild injury that worsens with age, resulting in tinnitus or sudden hearing loss as in Meniere's disease, for example.

Who would have a motive to advance a false story? "I think it is people that the U.S. government listens to, who want to roll back Obama's work with Cuba, and they are taking advantage of this," Valdés-Sosa says, suggesting perhaps some embassy personnel became ill from natural or preexisting causes—but when U.S. officials told them a secret weapon was involved, their anxiety may have skyrocketed.

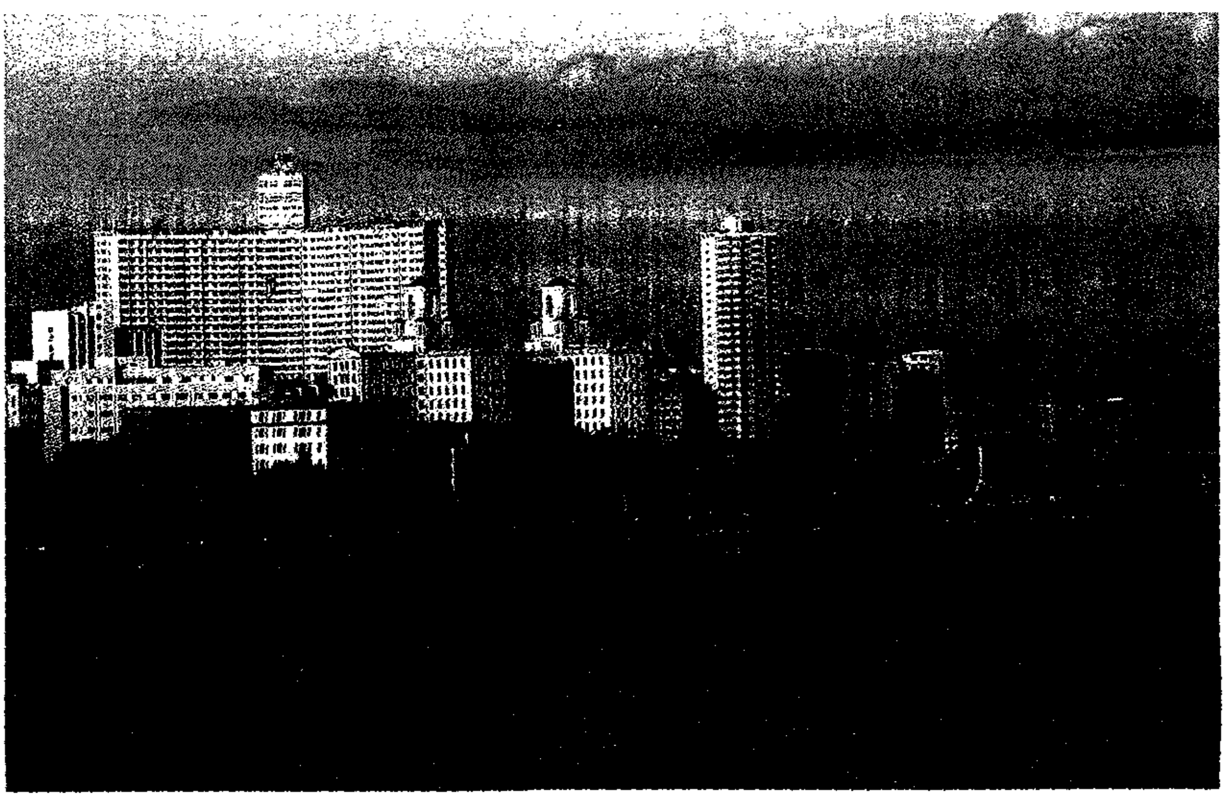
Many ordinary Cubans were also incredulous about the idea of an intentional attack, and insisted that their country is highly motivated to improve relations with their gigantic neighbor.

"Science fiction," says a restaurant worker in Havana, using a phrase often heard on the streets of the capital when this issue comes up. And one night in a remote village, as people dance salsa to the rhythm of Congo drums in the town square, a professional dancer says to me about the idea of an advanced new weapon: "I invite Americans to live in Cuba six months. We don't have anything. No internet, no weapons program, not even cars." Another Cuban adds, "If we had such a weapon, which we don't, why would we use it on embassy employees and their families? We would not need bombs. We would take it to Trump Tower."

Back in Havana, a taxi driver in a 1942 Ford Fleetwood that jostles its rickety way through the streets in a predawn rain—the darkness pierced by one working headlight as the taxi driver squints through a streaky windshield—says point blank in broken

The incident has also mystified some U.S. officials. "Very perplexing," said Sen. Tom Udall (D–N.M.), after questioning Palmieri at the January 9 Senate hearing. "We need to be careful not to jump to conclusions until we know what really happened." The same day, Secretary of State Rex Tillerson announced he would request an independent review board to investigate the matter.

Valdés-Sosa ends our meeting, reflecting aloud: "If this is a hoax, it is cruel to have these people living under a shadow for the rest of their lives. Establishing what happened is important not only for the two countries, but for the people involved. The only way to do it is to share scientific information."



Department concludes it was harassment.

December 2016–January 2017: Employees first visit the State Department medical unit.

February–April 2017: 80 employees are examined; 16 are determined to have suffered mild traumatic brain injury.

July 2017: The State Department's Bureau of Medical Services convenes a panel of academic experts to examine case histories and medical records. They conclude victims suffer "trauma from a non-natural source."

August 2017: The Center for Brain Injury and Repair at the University of Pennsylvania reevaluates the initial cases and later ones occurring until August 2017, bringing the total to 24 employees with mild traumatic brain injury.

ABOUT THE AUTHOR(S)

R. Douglas Fields

R. Douglas Fields is a neuroscientist and author of *Why We Snap*, about the neuroscience of sudden aggression, and the soon-to-be-published *Electric Brain*, about brain waves and brain-stimulation research. Fields is an adjunct professor at the University of Maryland, College Park, in the neuroscience and cognitive science program and chief of the nervous system development and plasticity section at the National Institute of Child Health and Human Development.

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At forum, concerns raised about health impacts from large turbines

Photo by Tom Rivers: Rob Rand, a member of Institute of Noise Control Engineers, urges bigger setbacks for turbines to help protect residents from infrasound, which penetrates walls and disrupts sleep for many people. Rand runs Rand Acoustics in Brunswick in Maine.

By Tom Rivers, Editor Posted 11 September 2019 at 9:04 am

Experts say low-frequency infrasound has debilitating effects on about 10% of population who live near turbines

WILLIAMSVILLE – Wind turbines aren't the noise-free, idyllic structures that are typically presented to be, said several speakers at a forum Tuesday on the public health impacts of industrial wind turbines.

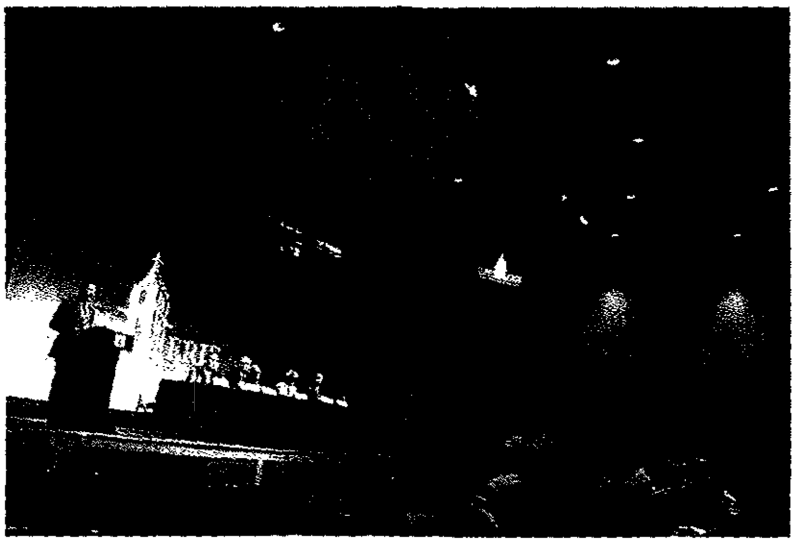
The turbines, which tower more than 400 feet high, not only change the looks a rural landscape, but they have shadow flicker and infrasound that effect the health of many residents near the turbines.

Infrasound, in particular, is a very real problem, where low-frequency sound waves hurt disrupt the sleep and have debilitating effects on about 10 percent of the population, said Dr. Jerry Punch, a certified audiologist for over 50 years. He works at Michigan

State University.

"I'm not saying everyone will get sick, but some will complain of health effects," Punch told about 100 people Tuesday during the forum organized by State Sen. Robert Ortt at Erie Community College's North Campus. "There is enough scientific evidence that infrasound causes annoyance and health effects. If not sited properly, the impacts would occur in substantial proportion of the population."

Apex Clean Energy is working on projects in Barre and Yates-Somerset. Other wind energy developers have completed projects in Western New York, and Ortt said he expects more will be coming after the State Legislature and Gov. Andrew Cuomo passed the Climate Leadership and Community Protection Act, with a goal of achieving a carbon-neutral economy by 2050.



State Sen. Robert Ortt speaks during a forum Tuesday at Erie County Community College's North Campus. He is joined by panelists, from left: Assemblyman Mike Norris, R-Lockport; Rob Rand, member of INCE (Institute of Noise Control Engineers); Jerry Punch, Ph.D., audiologist; Gary Abraham, an environmental attorney; and Dan Stapleton, Niagara County Commissioner of Health.

Ortt said the state will be pushing wind energy, solar and other renewable energy to meet those targets. Western New York and upstate will see more renewable energy projects because of the state's carbon-neutral goals, Ortt said.

"If you live in a rural community you will see more of these kind of projects," he told the crowd.

He said developers will likely pick poorer, rural communities.

"You don't see turbines in affluent areas," he said.

State officials need to consider the harm on some residents' mental and physical health with siting projects, Ortt said.

"These are impacts we need to discuss because of the energy goals," Ortt said. "We're going to see more of these type of projects. At some point this will effect a lot of people not just in Western New York, but in Upstate New York."

Linda Makson lives in Orangeville, Wyoming County, where Invenergy has had a turbine project since 2014.

***Linda Makson of Orangeville** said her house is surrounded by wind turbines.*

"Every single window I look out I see one," she said at the forum.

She and her husband Paul have lived in Orangeville since 1973. It was peaceful, but that changed with the turbine project, including during construction with "an incessant beep, beep, beep" from construction vehicles, and the dust in the air, she said.

The shadow flicker from the turbines, which bothers her about a half hour each day, "is nauseating. The flicker makes me feel sick."

The flicker is short term, while the noise is far more frequent, and the turbines also have blinking red lights at night.

"We have lost vistas," she said about the visual impact. "We expect to see the beauty of the land."

Makson said she suffers headaches and stress from the noise, which disrupts her sleep.

Headaches and continued stress and noise

"The noise can be heard in my house even with the doors and windows closed," she said. "There are days the turbines just roar."

Lynn Bedford of Chautauqua County said living near wind turbines "is a form of torture."

Lynn Bedford has seven 500-foot-tall turbines near her home in Arkwright Hills, Chautauqua County. EDP Renewables of North America started operating the 78.4 megawatt wind energy project in Arkwright, which is near Fredonia, last year.

Bedford said one of the turbines is within 1,000 feet of her home. EDP has 36 turbine sin Arkwright and they became operational last September.

"Within 24 hours my ears began to ring, it hasn't stopped," Bedford said. "It has affected my sleep habits. I became a victim of an uncontrollable circumstance."

Bedford said she has become an emotional roller-coaster since the project started. She also has begun to lose vision in an eye and her heart pounds.

"The sleep deprivation has been the worst," she said at the forum. "Some days I feel like I'm going to lose my mind. My human body is being attacked by something called infrasound. Infrasound is a weapon of war."

Bedford has 29 grandchildren and five great-grandchildren. She is determined to fight the wind turbine project.

"In Arkwright it's a form of torture," she said about living by turbines. "This is actually a crime against humanity. Something must be done about it. I pray someone will put an end to this wind turbine nightmare."

Dan Stapleton, Niagara County Commissioner of Health, has concerns with large-scale wind turbines.

Dan Stapleton, the Niagara County Commissioner of Health, also is president of a statewide association of health officials (New York State Association of County Health Officials) and a member of the Western New York Health Alliance. Those groups have all passed formal resolutions seeking for full environmental impact studies with turbine projects, including the impacts on human health.

"I don't call them wind farms," Stapleton said. "I call them industrial wind turbines."

He said he and health officials aren't against renewable energy projects, they just want detailed health impact studies.

"It shouldn't be incumbent on the residents to prove it's unsafe," he said. "It should be incumbent on the developers to prove it is safe."

The Health Department works every day with people suffering from chronic disease. Stapleton said sleep deprivation – either not enough sleep or not enough quality sleep – has an impact on human health.

"We're talking about a large-scale project," he said. "It is imperative to fully research and assess health implications that could put residents at risk from large industrial wind turbines."

Dr. Jerry Punch, an audiologist, said turbine noise is more harmful to some people than hearing aircraft and rail traffic.

Jerry Punch, Ph.D., has worked as an audiologist for more than 50 years. He said about 10 percent of the population near large-scale wind turbines will suffer "annoyance" and sleep disruption from turbine noise.

The low-frequency infrasound can't be heard, but it is felt by about 10 percent of the population near turbines, he said.

For them, the infrasound can be debilitating. He has met families in Michigan who had to leave their homes at night to sleep in motels. One family who fled their homes had turbines within 1,300 to 2,000 feet of their house.

Wind turbine noise has unique characteristics, he said.

"What we can't hear can hurt us," he said. "Infrasound is below threshold of audibility. Even though you can't hear it can be perceived."

The turbines are more operational at night-time, when it is quieter in a house. And turbines tend to be sited in quiet, rural areas.

Some people will suffer migraines, reduced quality of life, vomiting, extreme headaches, and changes in heart rate, he said.

He advocates for bigger setbacks. Some communities only account for the size of the turbines and blade throw, if a blade broke off. But Punch said the noise impacts need to be considered, with the turbines pushed farther away from people.

He said some experts suggest minimum distances of 0.5 to 2.5 miles, while many researchers suggest minimum of 1.25 miles.

Robert Rand said people suffering from wind turbine noise shouldn't be discounted.

Robert Rand, owner of Rand Acoustics in Maine, has worked as a noise consultant for nearly 40 years. He visited a wind turbine project and suffered with headaches and poor balance for seven weeks after that.

"I'm in that 10 percent of the population that is immediately susceptible," Rand said. "I could not live near a wind farm."

He said there is an impression that turbines don't make noise, but they do, and that noise is difficult for some people to bear.

The turbines have a pulsating low-frequency noise. It isn't steady. About every second the turbines will have a leak noise noise while the blades are spinning. That pulsating can trigger a feeling like motion sickness for some people, Rand said.

"Distance is the only reliable noise control option," he said. "In most places there isn't enough distance to avoid impacts."

The noise can feel like a "thumping" at nighttime, disturbing sleep for some residents, he said.

"There is some suggestion that people are making this up," Rand said. "I can tell you from my direct experience people aren't making this up."

Rand said he is concerned as developers propose larger turbines topping 600 feet in what are very quiet, rural areas.

"As they've gotten larger the problem has gotten exacerbated," Rand said. "It's gotten worst."

Gary Abraham, *an environmental attorney,* urges towns to pass wind energy laws that protect the health of residents.

Gary Abraham, an environmental attorney, has worked with municipalities to draft local ordinances with setbacks to better protect residents from noise, shadow flicker and other intrusiveness negative effects from turbines.

Although the state has created a Siting Board to review energy projects with more than 25 megawatts, Abraham said local ordinances still are considered in siting projects.

He said noise is a big impact from turbines, especially with the pulsations every second when the turbines are spinning.

He wants the Siting Board to consider the noise impacts at night.

"It's not a constant hum," he said. "You're getting a noise event every second with the pulsations from wind turbines."

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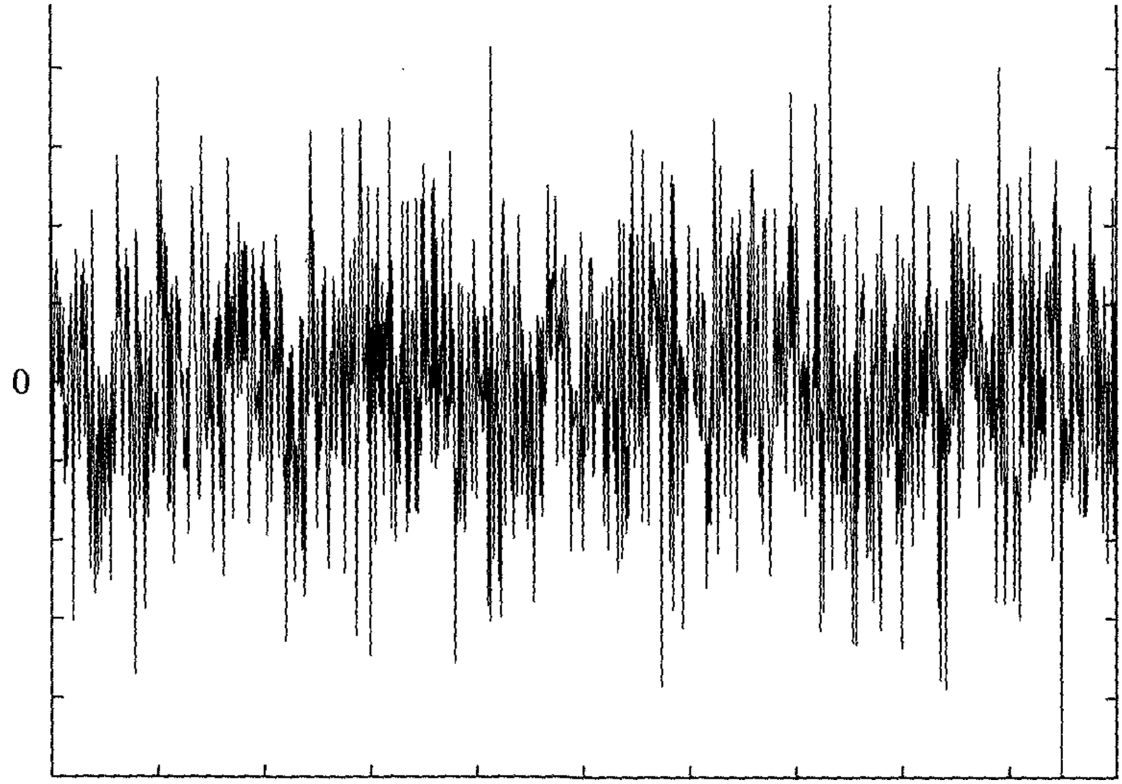

02 JUL OCCUPATIONAL VIBRATION EXPOSURE

Posted at 08:47h in Safety Manual, Safety Topics, Tailgate Safety, Tailgate Safety Meetings, Toolbox Talks by

OCCUPATIONAL VIBRATION EXPOSURE

Many workers do not think that their exposure to vibration could be a health hazard. Vibration exposure is more than just a nuisance. Constant exposure to vibration has been known to cause serious health problems such as back pain, carpal tunnel syndrome, and vascular disorders. Vibration related injury is especially prevalent in occupations that require outdoor work, such as forestry, farming, transportation, shipping, and construction. There are two classifications for vibration exposure: whole-body vibration and hand and arm vibration. These two types of vibration have different sources, affect different areas of the body, and produce different symptoms.

Whole-body vibration is vibration transmitted to the entire body via the seat or the feet, or both, often through driving or riding in motor vehicles (including fork trucks and off-road vehicles) or through standing on vibrating floors (e.g., near power presses in a stamping plant or near shakeout equipment in a foundry).

Hand and arm vibration, on the other hand, is limited to the hands and arms and usually results from the use of power hand tools (e.g., screwdrivers, nutrunners, grinders, jackhammers, and chippers) and from vehicle controls.

Occupational health effects of vibration result from extended periods of contact between a worker and the vibrating surface. What are the possible health effects of chronic whole-body vibration and hand and arm vibration exposure?

Whole-body Vibration:

- Back pain

Hand and Arm Vibration:

- Decreased grip strength
- Decreased hand sensation and dexterity
- Finger blanching or "white fingers"
- Carpal tunnel syndrome

Currently, there are no legal standards that limit exposures to vibration. However, there are many ways employers and workers can help to reduce workers' exposure to vibration.

Whole-body vibration levels can often be reduced by using vibration isolation and by installing suspension systems between the operator and the vibrating source.

Hand and arm vibration may be more difficult to control, but the proper selection and maintenance of tools can dramatically decrease vibration exposure. Vibration levels associated with power hand tools depend on tool properties, including size, weight, method of propulsion, handle location, and the tool drive mechanism. Primary prevention through eliminating excessive vibration and shocks can be accomplished through better ergonomic tool designs.

Administrative controls can be very important. In high-risk situations, job rotation, rest periods, and reduction in the intensity and duration of exposure can help reduce the risk of adverse health effects.

All workers should be advised of the potential vibration hazard and receive training on the necessity of regular tool maintenance and be taught to grip the tools as lightly as possible within the bounds of safety.

Early prevention through exposure monitoring and through the early reporting of initial signs and symptoms of vibration exposure can dramatically reduce chronic health effects.

TAGS: hearing, noise, Occupational Vibration Exposure

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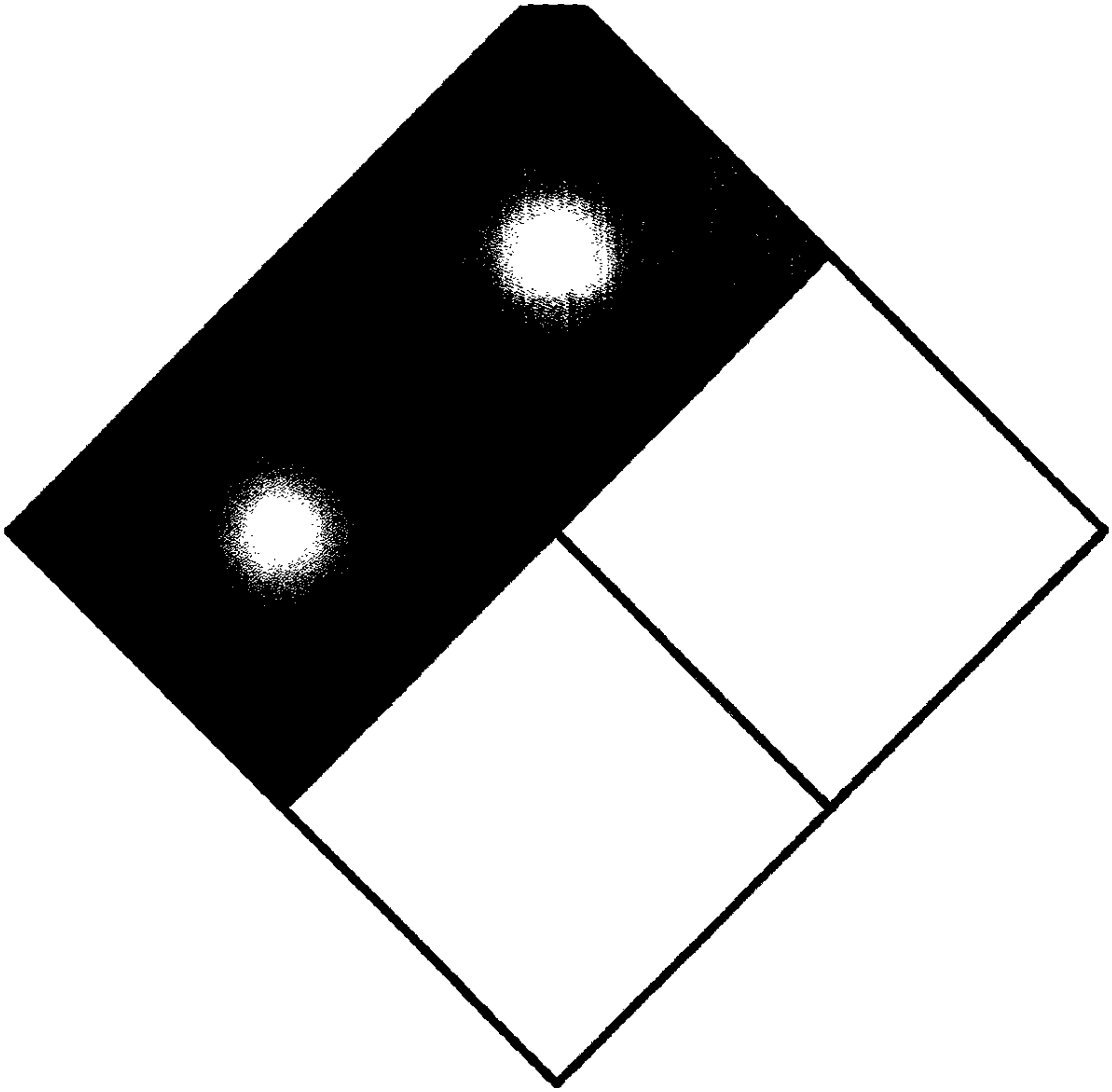


02 MAR HAZCOM VS. HAZMAT VS. HAZARDOUS WASTE

Posted at 16:11h in Safety Manual, Safety Topics, Tailgate Safety, Tailgate Safety Meetings, Toolbox Talks by

HAZCOM VS. HAZMAT VS. HAZARDOUS WASTE

What Is The Difference?????

AT LAST REPORT there were 213,000 chemicals and chemical compounds being used in this country. And each year thousands of *new* chemical compounds are produced and become part of our lives at home and at work. Nearly 1.5 billion tons of hazardous materials are transported annually in the U.S., over the road or by rail, aircraft or vessel. A lot of these products improve our lives, but many are harmful to our health and to the environment. The trouble is, these substances become so common to us, we are in danger of using them casually.

A hazardous material is defined as: "A substance (gas, liquid or solid) capable of creating harm to people, the environment, and property." Examples are; solvents, paints, gasoline, adhesives and lubricants. They include materials as common as Drano and as toxic as nuclear fuel. Many people have suffered serious health problems from exposure to hazardous materials. Many areas of our environment have been critically damaged by accidental chemical releases. Trying to understand all the government agencies that regulate these matters is mind-boggling. But, we must all understand the potential harm in these materials, and how to use them and dispose of them properly.

DEFINITIONS:

The term *HAZCOM* refers to the Hazard Communication Standard, which requires that employees receive training about the chemicals they use in their work. This is sometimes called the "Workers' Right To Know" program. OSHA requires all employers to implement this program.

- The term *HAZMAT* is often used when discussing the transport or clean up of hazardous materials, but it actually can mean any *aspect* of hazardous materials production, transport, use, disposal, cleanup, or emergency response. OSHA and the EPA are major agencies of concern.
- *HAZARDOUS WASTE* is a contaminated chemical or by-product of a production process that no longer serves its purpose and needs to be disposed of in accordance with the Environmental Protection Agency. This could include small amounts of chemicals such as parts washing solvents in a machine shop, or large amounts of construction by-products.
- HAZWOPER refers to training that deals with hazardous waste operations and emergency response to chemical spills or releases.

A FEW THINGS TO REMEMBER ABOUT HAZARDOUS MATERIALS:

- Manufacturers must provide a Safety Data Sheet with all hazardous products they sell.
- Materials in transport must be properly labeled, e.g., flammable, explosive, radioactive, etc.
- The SDS must be available to any employee who works with or transports

- The SDS must be available to any employee who works with or transports such products.
- The SDS explains the physical and health effects of hazardous substances and how to avoid harm.
- The SDS explains procedures for spills, leaks and disposal.
- Hazardous materials or by-products such as gases cannot always be seen or smelled.
- Internal or external harm from exposure does not always appear immediately.
- Every employee who works with or near large quantities of hazardous materials must know the steps to take and who to contact in the event of a spill.

TAKE CARE WITH CHEMICALS:

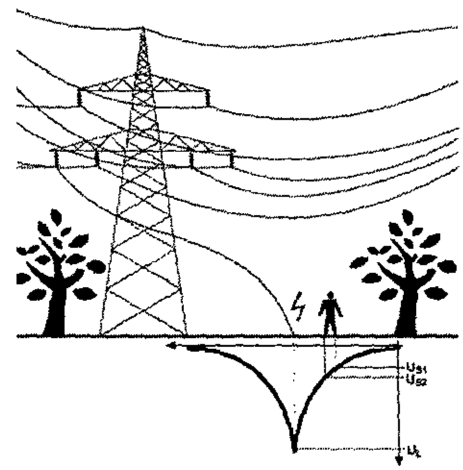
- They can make your life and work easier
- But they can take your life, too!

TAGS: GHS, hazard communication, hazcom, hazmat

WIKIPEDIA

Stray voltage

Stray voltage is the occurrence of electrical potential between two objects that ideally should not have any voltage difference between them. Small voltages often exist between two grounded objects in separate locations, due to normal current flow in the power system. Large voltages can appear on the enclosures of electrical equipment due to a fault in the electrical power system, such as a failure of insulation.



A fallen power conductor from a transmission line forces current through the earth; the resistance of the earth to current produces a voltage difference between the point of contact and distant earth. If the rate of change of voltage with distance is large, a dangerous potential may exist between the feet of a person in the area.

Contents

Terminology

Stray voltage is any case of undesirable elevated electrical potential, but more precise terminology gives an indication of the source of the voltage. **Neutral to earth voltage (NEV)** specifically refers to a difference in potential between a locally grounded object and the grounded return conductor, or neutral, of an electrical system. The neutral is theoretically at 0 V potential, as any grounded object, but current flows on the neutral back to the source, somewhat elevating the neutral voltage. NEV is the product of current flowing on the neutral and the finite, non-zero impedance of the neutral nductor between a given point and its source, often a distant substation. NEV differs from accidentally energized objects because it is an unavoidable result of normal system operation, not an accident or a fault in materials or design.

Definitions

Official definition (draft)

In 2005, the Institute of Electrical and Electronics Engineers (IEEE) convened Working Group 1695 in an attempt to lay down definitions and guidelines for mitigating the various phenomena referred to as stray voltage. The working group attempted to distinguish between the terms *stray voltage* and *contact voltage* as follows:

- **Stray voltage** is defined as "A voltage resulting from the normal delivery and/or use of electricity (usually smaller than 10 volts) that may be present between two conductive surfaces that can be simultaneously contacted by members of the general public and/or their animals. Stray voltage is caused by primary and/or secondary return current, and power system induced currents, as these currents flow through the impedance of the intended return pathway, its parallel conductive pathways, and conductive loops in close proximity to the power system. Stray voltage is not related to power system faults, and is generally not considered hazardous."[1]
- **Contact voltage** is defined as "A voltage resulting from abnormal power system conditions that may be present between two conductive surfaces that can be simultaneously contacted by members of the general public and/or their animals. Contact voltage is caused by power system fault current as it flows through the impedance of available fault current pathways. Contact voltage is not related to normal system operation and can exist at levels that may be hazardous."[2]

Working definition

In spite of the above definitions, the term *stray voltage* continues to be used by both utility workers and the general public for *all* occurrences of unwanted excess electricity. For example, at the annual "Jodie S. Lane Stray Voltage Detection, Mitigation & Prevention Conference", held at the Con Edison headquarters in New York City in April 2009, which attracted the presidents of most major utilities from throughout the United States and Canada, the utility leaders continued to use *stray voltage* for all occurrences of unwanted excess electricity. The term *contact voltage* was used only once, possibly because "contact voltage" is generally the fault of the supply, network or installation company. Few companies are willing to openly discuss faults of theirs, let alone ones as life-threatening. It would seem that *stray voltag* is now the common term for all unwanted voltage leakage as it categorises the fault as part of normal operation, therein limiting liability.

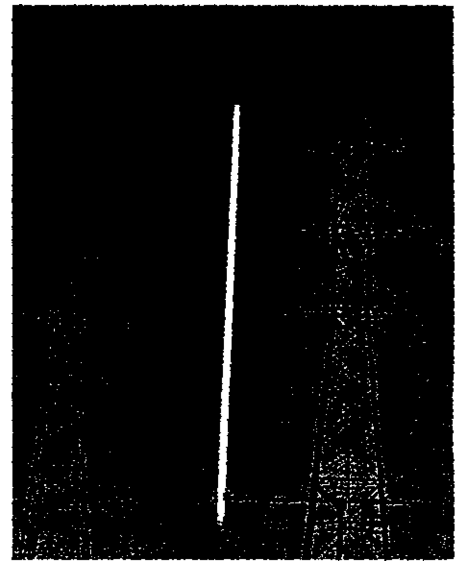
In New York City, a woman named Jodie S. Lane was electrocuted by a five-foot by eight-foot road utility vault plate energized by an "improperly insulated wire" in January 2004.[3] In the coverage of the growing concern regarding the role of public utilities in electrical safety in the urban environment that her death triggered, both the media and the New York state regulatory agency used *stray voltage* was for neutral-to-earth voltage (NEV), but conceded that the notoriety of the Jodie S. Lane incident had caused *stray voltage* to be a term that is well recognized by the public. At that point, the regulator used *stray voltage* for any "voltage conditions on electric facilities that should not ordinarily exist. These conditions may be due to one or more factors, including, but not limited to, damaged cables, deteriorated, frayed or missing insulation, improper maintenance, or improper installation."[4] In the same document, the commission accepted NEV to be a naturally occurring condition.

Since that time, the term “stray voltage” has had at least two very different definitions. This situation is cause for confusion among utilities, regulators, and the public.[5] The term "stray voltage" is commonly used for all unwanted electrical leakage, by both the general public and many electrical utility professionals. Other more esoteric phenomenon that also result in elevated voltages on normally non-energized surfaces, are also referred to as “stray voltage.” Examples are voltage due to capacitive coupling, current induced by power lines, EMF, lightning, earth potential rise, and problems stemming from open (disconnected) neutrals.

Origins

Coupled voltages

Ungrounded metal objects close to electric field sources such as neon signs or conductors carrying alternating currents can have measurable voltage levels caused by capacitive coupling. Since voltages detected by high-impedance instruments disappear or become greatly reduced when a low impedance is substituted, the effect is sometimes called **phantom voltage** (or **ghost voltage**).[6] The term is often used by electricians, and might be seen, for example, when measuring the voltage at a lighting fixture after removing the bulb. It is not unusual to measure phantom voltages of 50–90 volts when testing the wiring of ordinary 120 V circuits with a high-impedance instrument. While the voltage produced may read almost to the full supply voltage, the capacitance or mutual inductance between the wires of building wiring systems is typically quite low and incapable of supplying significant amounts of current.[7]


The very small capacitance between overhead lines and a fluorescent lamp tube (in the foreground of the photo) provides enough current to cause the lamp to glow.

However, in overhead transmission work on or near high-voltage lines, safety rules require connecting a conductor to earth ground during maintenance, since induced voltages and currents on a conductor may be sufficient to cause electrocution or serious injury.

Capacitive leakage through insulation

Alternating current is different from direct current in that the current can flow through what would ordinarily seem to be a physical barrier. In a series circuit, a capacitor blocks direct current but passes alternating current.

In power transmission systems, one side of the circuit, known as the neutral, is grounded to dissipate static electricity and to reduce hazardous voltages caused by insulation failure and other electrical faults. It is possible to get a shock by only touching the *hot* wire, due to the person's body being capacitively coupled to the ground upon which the person stands, even if the person is standing on an insulated surface.

Induced voltages

Classical electromagnetic induction can occur when long conductors form an open grounded loop under and parallel to transmission or distribution lines. In these cases, current is induced in the loop when a person makes contact with it and ground. Since this involves real current flow, it is potentially hazardous. This type of induced current occurs most often on long fences and distribution lines built under high-power transmission lines.[8][9]

Degraded insulation on power conductors

Stray voltage may be caused by damaged or degraded insulation. Failing insulation is essentially a high impedance fault which will allow current to flow through any available path to ground, a condition which can cause shocks or fires if left unmitigated. This leakage can occur when there is damage caused by physical, thermal, or chemical stresses to insulation on power lines, especially but not limited to underground or underwater cables. Examples of this damage are swollen or cracked insulation from overheating, abrasions caused by digging or ground seizing, and corrosion damage from salt or oil exposure. Electrical leakage can also occur due to moisture, salt, dust, and dirt buildup on open air insulators in overhead power distribution. If the leakage in these cases is severe enough, it can lead to a pole fire.

Leakage from single-wire earth return

The term "stray voltage" is used for the gradient (rate of change with respect to distance) of electrical potential in the surface of the soil, associated with single-wire earth return electricity distribution systems used in some rural locations. This gradient is low at points far away from the earth return connections, but increases near the ground rods where th metallic circuit enters the earth.

Neutral return currents through the ground

In three phase four-wire ("wye") electrical power systems, when the load on the phases is not exactly equal, there is some current in the neutral conductor. Because both the primary and secondary of the distribution transformer are grounded, and the primary ground is grounded at more than one point, the earth forms a parallel return path for the neutral current, allowing part of the neutral current to continuously flow through the earth. This arrangement is partially responsible for stray voltage. [10]

Stray voltage is a result of the design of a 4 wire distribution system and as such has existed as long as such systems have been used. Stray voltage became a problem for the dairy industry some time after electric milking machines were introduced, and large numbers of animals were simultaneously in contact with metal objects grounded to the electric distribution system and the earth. Numerous studies document the causes,[11] physiological effects,[12] and prevention,[13][14] of stray voltage in the farm environment. Today, stray voltage on farms is regulated by state governments and controlled by the design of equipotential planes in areas where livestock eat, drink or give milk. Commercially available neutral isolators also prevent elevated potentials on the utility system neutral from raising the voltage of farm neutral or ground wires.

Electrolysis and corrosion

Dissimilar buried metals such as copper and steel can function as the poles of a galvanic cell, using moist soil as the electrolyte. Stray direct currents in soil may counteract the anti-corrosion effect of a cathodic protection system. Design of high voltage direct current transmission systems must take care so that current flowing in the earth does not cause objectionable corrosion to buried objects such as pipelines.

Typically an electric railway will have at least one of the rails used as a return conductor for the traction current. This rail is in contact with the earth at many places throughout its length. Since current will follow every parallel path between source and load, some part of the traction current will also flow through the earth. Where the railway uses direct current, this stray current can cause damage to other buried metallic objects by electrolysis and accelerate corrosion of metal objects in contact with the soil.

Public concerns about stray voltage

In metropolitan areas, stray voltage issues have become a major concern. Many of these areas have large amounts of aging underground and aboveground electrical distribution equipment in crowded public spaces. Even a low rate of insulation failures or current leakage can result in hazardous exposure of the general public.

Consolidated Edison in New York City has had frequent incidents of stray voltage,[15][16] including the electrocution death of Jodie S. Lane in 2004, while walking her dog in Manhattan.[15] In 2009, the Jodie S. Lane Public Safety Foundation[17] announced a publicly accessible website with maps showing thousands of reported stray voltage locations in New York City. In addition, the Foundation sponsors the "Jodie S. Lane Stray Voltage Detection, Mitigation & Prevention

Conference", an annual meeting attended by power utilities and regulators from around the country to discuss stray voltage detection programs. The Foundation also initiated and advocates regular mobile scanning by utility companies for stray voltage hazards.

In Boston, NSTAR Electric (formerly Boston Edison) has also had problems with hazardous stray voltages, which have killed several dogs during the 1990s.[18] As a result, the City of Boston government started a program to detect, report on, and repair stray voltage hazards.[19]

Toronto Hydro pulled all employees off regular duty on the weekend of January 30, 2009 to deal with ongoing stray voltage problems in the city.[20] This came after as many as five children were shocked [21] though none suffered serious injury. The stray voltage problem had claimed the lives of two dogs in the previous few months.[22]

In March 2013, Californian Simona Wilson won a $4 million lawsuit against her power company after stray voltage from a substation near her house repeatedly shocked her and members of her family whenever they were in the shower.[23]

Effects

Persons

Small stray voltages may never be noticed and may only be detected with a voltmeter. Larger voltages may have a range of effects, from barely perceptible to dangerous electric shocks, or unintended electrical heating resulting in fires. Normally, metal electrical equipment cases are bonded to ground to prevent a shock hazard if energized conductors accidentally contact the case. Where this bonding is not provided or has failed, a severe hazard of electric shock or electrocution is presented when circuit conductors contact the case.

In any situation where energized equipment is in intimate electrical contact with a person or animal (such as swimming pools, surgery, electric milking machines, car washes, laundries, and many others), particular attention must be paid to elimination of stray voltages. Dry intact skin has a higher resistance than wet skin or a wound, so voltages that would otherwise be unnoticed become significant for a wet or surgical situation. Potential differences between pool water and railings, or shower facilities and grounded drain pipes are not uncommon as a result of neutral to earth voltages (NEV), and can be a major nuisance, but are usually not life-threatening. However, contact voltage resulting from damaged insulation on a current carrying conductor can be very dangerous, and can lead to shock or electrocution. Such a condition can arise spontaneously from mechanical, thermal, or chemical stress on insulation materials, or from unintentional damage from digging activity, freeze-frost seizing, corrosion and collapse of conduit, or even workmanship issues.

Contact voltage energizes objects which are normally safe – fences, telephone booths, street signs, etc. Anywhere buried electric wiring exists, a failure can occur in that wiring and create conditions that allow electricity to flow into the immediate surroundings. Some systems have protective devices such as circuit breakers or Ground Fault Circuit Interrupters (GFCI), designed to isolate such a fault. However, in the absence of protective devices, if the devices fail, or if they are not installed correctly, a fault will go undetected until it either causes a failure of the circuit or until it is found by a person.

Farm animals

Stray voltage can have harmful effects on animal health and productivity.[24] Some dairy farmers have claimed damage to yields or stock caused by it.[25]

Dr. Douglas J. Reinemann, Professor of Biological Systems Engineering at University of Wisconsin–Madison, reported on stray voltages on dairy farms in 2003.[26] Investigation of stray voltage claims must also consider other animal health concerns.

Legal proceedings in Wisconsin

In 2003, the Wisconsin Supreme Court upheld a judgement of $1.2 million against the Wisconsin electrical utility WEPCO in *Hoffman* v. *Wisconsin Electric Power Company*. The Hoffman family, dairy farmers near New London, had sued WEPCO after several years of declining production. WEPCO had measured on the farm currents due to stray voltage below one milliampere, the "level of concern" set by the Wisconsin Public Service Commission, but the court ruled on procedural grounds that the utility could be found negligent under common law even though they met the state standard. The Hoffmans had presented, the court said, a viable alternative theory that stray voltage had caused them economic harm.[27]

In 2017 a jury sided with farmers Paul and Lyn Halderson for a $4.5 million settlement against Xcel Energy. The Haldersons claimed stray voltage from power lines hurt their 1,000 cow herd and lowered milk production. The jury found that Xcel subsidiary — Northern States Power — was "negligent with respect to the delivery of electrical service." The jury awarded $4.09 million for economic damages and another $409,000 for "inconvenience, annoyance and loss of use and enjoyment" of property. [28]

Stray/contact voltage detection

Stray voltage is generally discovered during routine electrical work, or as a result of a customer complaint or shock incident. A growing number of utilities in urban areas now conduct routine periodic and systematic active tests for stray voltage (or more specifically, contact voltage) for public safety reasons. Some incipient electrical faults may also be discovered during routine work or inspection programs which are not specifically focused on stray voltage.

Equipment used to detect stray voltage varies, but common devices are electrical tester pens or electric field detectors, with follow-up testing using a low-impedance voltmeter. Electrical tester pens are hand-held devices which detect a potential difference between the user's hand and the object being tested. They generally indicate on contact with an energized object, if the potential difference is above the sensitivity threshold of the device. Reliability of the test can be affected if the user is at an elevated potential him/herself, or if the user is not making firm contact with a bare hand on the reference terminal of the tester.

Capacitive coupling is the mechanism used by electrical tester pen devices. Because the capacitance between an object and a current source is typically small, only very small currents can flow from the energized source to the coupled object. High-impedance digital or analog voltmeters may measure elevated voltages from non-energized objects due to this coupling, in effect providing a misleading reading. For this reason, high-impedance voltage measurements of normally non-energized objects must be verified.

Verification of a voltage reading is performed using a *low-impedance* voltmeter, which usually has a shunt resistor load bridging the voltmeter terminals. Since very little current can flow from a coupled surface through the small shunt or meter resistance, capacitively coupled voltages will collapse to zero, indicating a harmless "false alarm". By contrast, if an object being tested is in contact with a current source, or coupled by a very large capacitance (possible but unlikely in this context), the voltage will drop only slightly as dictated by Ohm's Law. In this latter case, real power is being delivered, indicating a potentially hazardous situation.

Electric field detectors detect the electric field strength relative to the user's body or mounting platform. By sensing electric field gradients at a distance, they can detect energized objects without making direct contact, making these instruments useful for scanning or screening large areas for potential electrical hazards. A low electric field reading also provides a definitive indication that no objects are energized within a tested area. Electric field detectors respond to all field sources, and any positive indications must be verified with a low-impedance voltmeter to eliminate false positives. Electric field proximity sensing also has other industrial applications from manufacturing to building security.

Since stray voltage can not be seen, smelled or heard, there is no easy way for the public to know when a dangerous condition exists. Periodic testing is an important precaution, but it is possible that a dangerous condition can develop without warning.

See also

- Disturbance voltage
- Earth potential rise
- Earthing system
- Electrical bonding
- Gas leak
- Neutral and ground
- Shaft voltage

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External links

- University of Wisconsin–Madison Report on Stray Voltage (http://www.uwex.edu/uwmril/stray_voltage/svmain.htm)
- 'Electrified Cover Safeguard' website (http://www.manholesafety.com/)
- 'Stray voltage' website (http://www.strayvoltage.org/) from the *LaCrosse Tribune*, including their award-winning coverage
- Self-Help Guide: Stray Voltage Detection (http://www.mrec.org/pubs/svd.pdf), Wisconsin Farm Electric Council (2/1997), well written, for farmer-consumers, at
  - Midwest Rural Energy Council (http://www.mrec.org/sv-info.html) Stray Voltage portal
- Wisconsin Public Service Stray Voltage site (http://www.wisconsinpublicservice.com/farm/stray.aspx)
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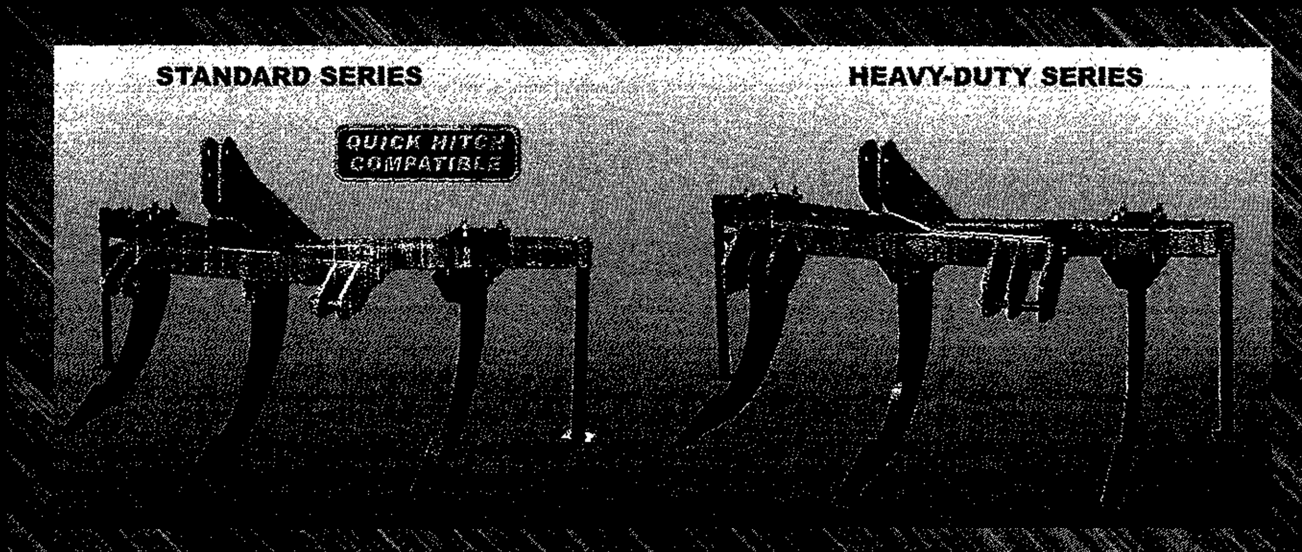
NORTHSTAR

V-RIPPERS



STANDARD & HEAVY-DUTY SERIES V-RIPPERS: **Standard Duty Series** are recommended for breaking up hardpan and compacted soil for improved soil aeration and increased yields. The 4" x 6" x 84" width tool bar is equipped with category 2, 3-point hitch, for tractors 50-80 HP and available with either 2 or 3 shanks. The 1" x 27" parabolic shanks are shear-bolt protected and equipped with high carbon heat-treated points. Standard series is quick hitch compatible. **Heavy-Duty Series** are ideal for deep ripping and break up of compacted soil to increase root growth, water penetration and yield. The rugged 5" x 7" tool bar is equipped with category 2 and 3, 3-point hitch, for tractors 80-195 HP, 3-shank model is available with 84" tool bar, 5 and 7 shank models with 144" tool bar widths. The high clearance 1-1/4" x 34" parabolic shanks are shear-bolt protected and equipped with high carbon heat-treated points

MODELS	227	327	334	534	734
NO. OF SHANKS	2	3	3	5	7
TOOL BAR WIDTH	84"	84"	84"	144"	144"
FRAME TUBE SIZE	4" x 6"	4" x 6"	5" x 7"	5" x 7"	5" x 7"
SHANK LENGTH	27"	27"	34"	34"	34"
SHANK SIZE	1" Parabolic	1" Parabolic	1-1/4" Parabolic	1-1/4" Parabolic	1-1/4" Parabolic
HITCH	Cat. 2	Cat. 2	Cat. 2 & 3	Cat. 2 & 3	Cat. 2 & 3
HP RATING	Up to 80	Up to 80	Up to 85	Up to 140	Up to 195
SHEAR-BOLT PROTECTION	Yes	Yes	Yes	Yes	Yes
WEIGHT	675	750	850	1700	2880
PARKING STANDS	Yes	Yes	Yes	Yes	Yes

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Archived

This topic is now archived and is closed to further replies.

What's the difference between subsoiling, ripping and zone building

By dannyredfan, April 7, 2014 in Coffee Shop

Start new topic

dannyredfan
Advanced Member

Members
139
978 posts
Gender:Male
Location:Rhodelia Ky.
Interests:working in the shop 1568 966 806 140 M,H and all the rest

Posted April 7, 2014

Hey everybody

Have been looking for a two shank subsoiler. We have a single one and its in fair shape would just like a bigger one, just not sure how many a 806 could pull(no turbo, but turned all the way up)

Would really just like to know the differences between the three peace's of equipment if any

TroyDairy
Advanced Member

Posted April 7, 2014

The 1st are the same around here. Kinda feel like rippers have a crescent curve and sub soilers are fairly straight shanked. Zone building......never heard of that.

T

Members
409
10,875 posts
Gender:Male
Location:Washington
Interests:Faith, Family, Dairy, Red tractors and stuff

Delta Dirt
Advanced Member

D

Members
575
4,517 posts
Location:Avon, Ms 38723

Posted April 7, 2014

Probably be worth your while to google "parabolic subsoiler"-----I think the interpertation of what a subsoiler and ripper might be varies in different parts of the country.

Regardless----the parabolic curve design will provide much more disturbance to the soil while requiring less horsepower versus the older straight shank designs. And---the subsoiler creates more disturbance to the soil than the smaller ripper shank. As to which

you need really depends on your particular soil composition---and the end results that you are seeking.

We run rippers and subsoilers here in the Delta-----and remember seeing 806s pulling two shank subsoilers back in the 60--70's. Seems like they had to keep a close eye on the hub/axle bolts (lots of torque passing through a weak point).

Dr. Gordon Tupper designed the parabolic shank at the Stoneville Experiment Station (close by).

Good luck

Delta Dirt

Avon Ms 38723

NY1468
Advanced Member

Posted April 8, 2014

Subsoilers are suppose to shatter the hard pan and zonebuilders are supposed to leave the hard pan in place with little disturbance other than small slits and cracks therefore drying the field and not creating a hard pan lower in the field.

Members
223
1,703 posts
Gender:Male
Location:northeastern NY
Interests:farming, red tractor collecting

At least that's the theory, roots are suppose to follow the slits down keeping them open. You are suppose to only do it two consecutive years so you would have these slits every 15" right over the corn row. It's more of a deep tillage for a no-till practice. Running a moldboard plow for instance after doing this application would be counterproductive. When using a zone builder, you are only suppose to run it a few inches below the hard pan, so if hard pan is 9-10" you would only run it at 13-14" deep. It works well if you use it right. Here is a good example....

boog
Advanced Member

Members
33
8,195 posts
Location:WC-IN
Interests:boogville , the BS capital of the world

Posted April 8, 2014

When we ran a subsoiler we ran between 20-22" deep. With a ripper we normally run 14-16" deep. I feel that an in-line ripper gives more "lift" & shatter to the upper portion of the soil while the subsoiler did it's work farther down, but that's just my thought. Would depend upong soil type and depth you run whether your 8 would handle a 2 shank subsoiler. Years ago we had an old 1 shank that we pulled with an M & SM hooked together. I used it a couple times behind an 806D to work out some low areas. Usually the 8 hardly knew it was back there but in places it would make the 806 grunt. Later on we pulled a 3 shank Blue-Jet subsoiler with a Magnum 7120 turnng 185hp. It gave the 7120 all it wanted in 7th & 8th. In places I would have to back up to get it out of the ground.

TP from Central PA
Advanced Member

Posted April 8, 2014

Members
707
8,319 posts
Gender:Male
Location:Arm pit of the earth
Interests:Soaking money into shipwrecks on tires........

We have a 2 shank setup we use to rip between tomato rows after planting..............Back when we chiseled we would pull the front end off the ground lifting on the headlands. Pulling it as fast as the tractor would handle it. Having since going back to moldboarding, we only run it on the planter tracks, and it doesn't pull nearly as hard. I don't think you would want anymore than 2 behind an 806, and like the others said, even that maybe too much.

1066smoker
Advanced Member

1

Members
0
3,421 posts
Gender:Male
Location:Frederick, MD
Interests:Farming, Miss my dairy cows Tractors, prefer IH, but I love em all If it has an engine, I interested in it

Posted April 8, 2014

We ran a single shank subsoiler behind a 706 gas years ago. Our ground pulls pretty hard

dannyredfan
Advanced Member

Members
139
978 posts
Gender:Male

Posted April 8, 2014

I have no problem useing one subsoiler shank

Most of my ground has not been croped in many many years

Just trying to optamise the ground

We have top soil about 8" 10" and yelow modeled clay under that

Really wet type of ground

Location:Rhodelia Ky.
Interests:working in the shop 1568 966 806 140 M,H and all the rest

Bleedinred
Advanced Member

B

Members
61
1,312 posts
Gender:Male
Location:Juliaetta, ID
Interests:Family, fly fishing, back country skiing, old machines,

Posted April 8, 2014

For a look at parabolic subsoiler shanks google Stoess Manufacturing, located in Washtucna, WA. My friends pull a heavy duty 7 shank model, a real beast.

BOBSIH856
Advanced Member

Members
48
3,476 posts
Gender:Male
Location:Coldwater, MI
Interests:Hobby farming, working on tractors, starting to restore the 8, spending time with wife and kids.

Posted April 8, 2014

> **On 4/7/2014 at 11:12 PM, dannyredfan said:**
>
> I have no problem useing one subsoiler shank
>
> Most of my ground has not been croped in many many years
>
> Just trying to optamise the ground
>
> We have top soil about 8" 10" and yelow modeled clay under that
>
> Really wet type of ground

Try tillage radishes Tanman gave me some good info on them late last fall. I'm going to try them in our pastures this fall.

TP from Central PA
Advanced Member

Posted April 8, 2014

> **On 4/8/2014 at 12:22 PM, BOBSIH856 said:**

Members
707
8,319 posts
Gender:Male
Location:Arm pit of the earth
Interests:Soaking money into shipwrecks on tires.........

> > **On 4/7/2014 at 11:12 PM, dannyredfan said:**
> >
> > I have no problem useing one subsoiler shank
> >
> > Most of my ground has not been croped in many many years
> >
> > Just trying to optamise the ground
> >
> > We have top soil about 8" 10" and yelow modeled clay under that
> >
> > Really wet type of ground
>
> Try tillage radishes Tanman gave me some good info on them late last fall. I'm going to try them in our pastures this fall.

Not going to get on a soap box, but we have been conducting some research here ourselves as our neighbor across the fence is a large part of "Cover Crop Solutions" here in the east but doesn't seem to practice what he preaches. All I will say here is we have found that in compacted areas the only thing that grew was the ity-bity tap root that was the size of a pencil point, while the rest grew up out of the ground(Path of least resistance)................Stay tuned for an agtalk post on the cover crop subject and using iron to remove compaction. We have been the scorn of the community here now for the last two years since mudding out a tomato crop then, after nonsense was spread about we ruin the ground and have no-sense of conservation. The pictures I have of our no-tilled and conventional tilled cover vs this "Expert's" fields will open some eyes I believe, and atleast I "HOPE" will get people to do their own research into the nonsense they are spewing while they are stealing your money on products they aren't using themselves.

BOBSIH856
Advanced Member
●●●

Members
48
3,476 posts
Gender:Male
Location:Coldwater, MI

Posted April 9, 2014

> **On 4/8/2014 at 3:22 PM, TP from Central PA said:**
>
> > **On 4/8/2014 at 12:22 PM, BOBSIH856 said:**
> >
> > > **On 4/7/2014 at 11:12 PM, dannyredfan said:**
> > >
> > > I have no problem useing one subsoiler shank
> > >
> > > Most of my ground has not been croped in many many years
> > >
> > > Just trying to optamise the ground

Interests:Hobby farming, working on tractors, starting to restore the 8, spending time with wife and kids.

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> Not going to get on a soap box, but we have been conducting some research here ourselves as our neighbor across the fence is a large part of "Cover Crop Solutions" here in the east but doesn't seem to practice what he preaches. All I will say here is we have found that in compacted areas the only thing that grew was the ity-bity tap root that was the size of a pencil point, while the rest grew up out of the ground(Path of least resistance)...............Stay tuned for an agtalk post on the cover crop subject and using iron to remove compaction. We have been the scorn of the community here now for the last two years since mudding out a tomato crop then, after nonsense was spread about we ruin the ground and have no-sense of conservation. The pictures I have of our no-tilled and conventional tilled cover vs this "Expert's" fields will open some eyes I believe, and atleast I "HOPE" will get people to do their own research into the nonsense they are spewing while they are stealing your money on products they aren't using themselves.

Tp send me some pictures of your test plot and what your study yields I'm always interested. I will check the ag talk forum what is the thread titled?

TP from Central PA

Advanced Member

●●●

Members
707
8,319 posts
Gender:Male
Location:Arm pit of the earth
Interests:Soaking money into shipwrecks on tires.........

Posted April 9, 2014

Will send the link when I get it up. I am not saying they are not a bad idea, problem we have with them is more the sales pitch and price, they are not and will never be a cure all end all. If the promoters are not users what does that say about their product?

Delta Dirt
Advanced Member

Members
575
4,517 posts
Location:Avon, Ms 38723

Posted April 10, 2014

Different soils, different crops, different weather patterns, amongst other different scenarios all contribute to what might work for one person and not for another.

As an old faded farmland appraiser and "poor enough to retire" farmer-----I suggest you get to know your Dirt (soil) composition. Your soil is your most valuable and basic investment (whether you own it or rent it)------get to know it well-----it's just like people (got different personalities)------be good to it and it will be good to you in return. Farming is hard enough when you do everthing right---------take the time to learn what best fits your situation.

One of the best ways of determing what your sub-surface situation really is------is to dig a verticle hole deep enough to know you are below the hard pan (sharpshooter, post hole digger, etc.). Take your trusty pocket knife and start at the bottom pulling upward with the knife---------you will feel the hard pan when the knife blade hits it and easily tell when you get above it. (This same scenario can be carried out with a soil probe--------but a few holes here and there just gives you such a better overall picture to start with-----then utilize the soil probes) The holes will also allow you to study your root patterns-----I have seen cotton tap roots take a right angle turn when they hit the top of an existing hard pan.

Measure to the top of the hard pan and then to the bottom---------to accomplish any measureable results, you need to operate what ever tillage tool you run at a depth below the hard pan.

In some of our Class I and II sandy loam soils here in the Delta area-------the soil scientists recommend sub soiling in the fall followed by a ripper shank down the top of the row in the spring. Believe it or not----------the pounding of winter rains can create hardpans over the winter months after the intial subsoiling in the fall.

Good luck to everybody on this years crop-----------I am beginning to see a little corn out of the ground down this way.

Delta Dirt

Avon Ms 38723

dannyredfan
Advanced Member

Posted April 10, 2014

We'll have thought about the radishes but seem expensive

Members
139
978 posts
Gender:Male
Location:Rhodelia Ky.
Interests:working in the shop 1568 966 806 140 M,H and all the rest

Found a two shank sub soiler they are the curved shank

Now just waiting for it to dry out a bit

Tonyinca
Advanced Member

T

Members
625
2,819 posts
Gender:Male
Location:Fresno , Calif.
Interests: Family, Agriculture Heritage, anything I.H.

Posted April 10, 2014

Back in the day we used our dueled up 806 with a 3pt Big Ox "V" shaped 5 curved shanks ripper to get past the plow pan.

Depending on the ground we pulled it to the max.

I Also remember when those v rippers came out with the 3pt 806's,1206's,4020's & 4320's and shortly after you would see many of those models sitting in the dealer shops getting rear end worked on. Finally the light went on to put gauge wheels on the rippers. It helped.

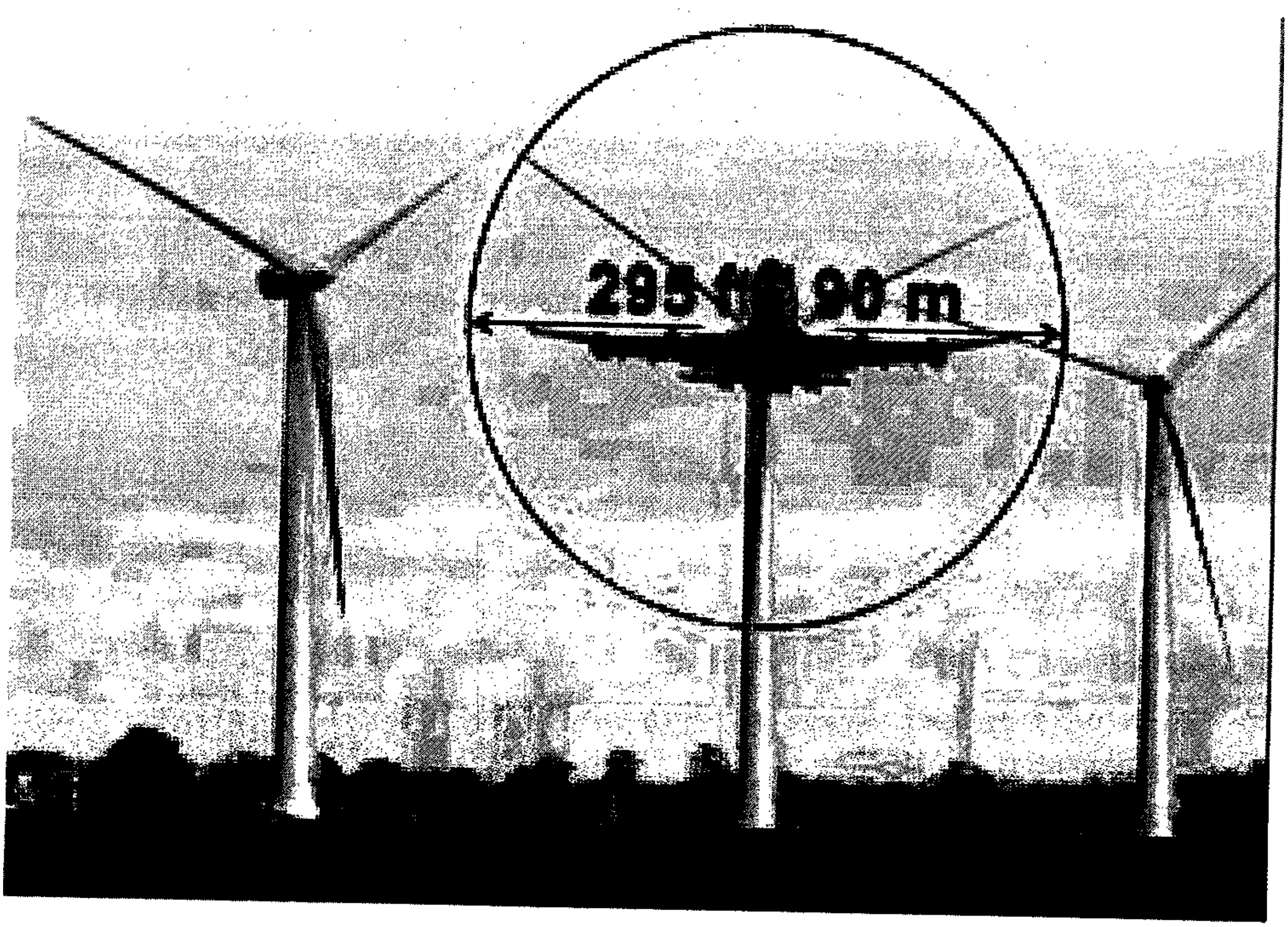
With our row crop tractors we tried getting 16-18" anything greater we brought in a D8 with two straight 4ft shanks and with swell we would get 3ft.penatration.

Tony

GO TO TOPIC LISTING

Home > Boards > Coffee Shop > What's the difference between subsoiling, ripping and zone building All Activity

EC&M



CONSTRUCTION

Don't Call Them Windmills

Electrical safety and wind turbine technology

Redwood Kardon, Code Check Institute | Feb 23, 2011

It was the fall of 1973. I'd been waiting in line to get gas for an hour, when a pimply teenaged pump attendant promptly dragged out a freestanding sign proclaiming, "No More Gas 'Til Tomorrow!" Ah, the good old days. For the first time, most of us old enough to remember those days were learning that America was not a self-sufficient country when it came to energy. OPEC had closed its oil spigot to America. We were mad as hell, and we needed to do something about it.

In reaction to this frightening reality, government and businesses scrambled for solutions. One approach was to mainstream the idea of "renewable energy." Wind energy seemed like a great answer to energy independence. Unfortunately, hastily conceived government construction subsidy programs lead to a flurry of unprofitable windmill installations. The poorly realized scale of turbine technology (i.e., too small), its bulky untested designs, and — most importantly — the normalization of oil prices in 1974 saw the wind energy industry quickly slide out of the spotlight of national energy policy. As a result, wind research and development in the United States all but ceased.

Before and after

Like most of the general public, back in those days, the term "windmill" conjured an image in my mind of tulips and quaint Dutch maidens dancing across a background landscape dotted with rustic windmills. As an apprentice electrician, I saw those stumbling first attempts as pretty marginal — not to mention inconsequential — to my nascent career.

While wind technology languished on the back burner in this country, countries like Denmark, Holland, Spain, Germany, and Japan stuck with it. Their persistent research and development put them in the forefront of today's wind power industry. However, America has done a pretty good job over the last few years of playing catch-up.

Today, we're seeing a massive effort to bring wind energy back to the forefront of power production in this country. Unlike the not-ready-for-prime-time attempts of the '70s, wind power is being developed with a technology that has a proven track record. In fact, the United States currently has more functioning wind turbines installed than any other country. This title will undoubtedly be short-lived, however, as China is rapidly catching up — and is expected to pass the United States in the next few years. Not surprisingly, China is already the largest manufacturer and exporter of wind turbines in the world.

In 2009, a Harvard study, "Global Potential for Wind-Generated Electricity," made the remarkable claim that there are enough developable wind energy locations in the lower 48 states to provide more than 16 times the total energy requirements of the entire United States. This study's results are based on current available technology (i.e., 2MW to 3MW turbines). That's right, 2MW to 3MW turbine/generators are current technology.

Photo 1. These turbines are typical of the scale of current wind turbines. The largest producing turbine in the world, however, boasts a blade diameter of 453 ft!

Here's where I want to explain the title of this article. The scale of current wind turbine technology is hard for most people to fathom. Today's wind turbines are a far cry from the stereotypical Dutch windmills most of us harbor. Instead, they're massive industrial marvels. For example, if you've ever been on the tarmac of a major airport and found yourself next to a Boeing 747 jumbo jet, you might have wondered how the heck that mountain of metal gets off the ground. It takes wings that are a colossal 211 ft from tip to tip. In comparison, the wing span (diameter of the circle drawn by turning turbine blades) of a typical 2MW wind turbine is 262 ft to 295 ft (**Photo 1**). The fundamental economic viability of wind farms depends on this enormous scale.

Operating voltages and system configuration

Turbines generate at various voltages, depending on the manufacturer and model. These generator output voltages can range from 480VAC to 1,000VAC. Several manufacturers generate at 690VAC. These turbines are especially difficult to inspect because they defy easy categorization in the NEC or IEEE standards. The NEC does not list 690V as a "nominal voltage." Rules for more than 600V are distinguished from rules for 600V and under. IEEE standards for power circuit breakers define low voltage as up to 635V.

Turbine voltages are stepped up at each tower to an industry standard of 34.5kVAC. This 34.5kVAC is then daisy-chained by underground cable runs called collector circuits. Most wind farms comprise multiple strings of turbines. Strings can be made up of as few as four turbines to as many as 16. Typically, three to six strings will terminate at a main bus in the substation powerhouse. Within the substation yard, voltage will be stepped up to the local utility's transmission voltage (i.e., greater than 69kV). Although 60MW to 80MW substations are most common, farm sizes as large as 500MW are in the pipeline.

Photo 2. Does this strain relief fastener arrangement for this 34.5kV cable meet code requirements?

One of the principal dangers on wind farms relates to the extremely high fault currents that are available when ground faults and short circuits occur on the system. One main source of fault currents is the numerous generators that are networked together. However, the most significant source of fault current on the wind farm is the transmission system to which the farm normally "backfeeds" power. Any transmission line capable of "receiving" significant amounts of power from the farm is then capable of "delivering" many times as much power should a fault occur. Catastrophic arc fault events have been the unfortunate result of a deadly mix of these astronomically available fault currents and novice electrical workers. Several years ago, one such fatal event helped initiate collaboration between our company and several wind turbine maintenance companies to develop electrical safe work practices training geared to the unique hazards associated with this rapidly growing industry.

Another common layout for towers is to locate a dry-type transformer "up-tower" and locate a medium-voltage SF6 gas-filled switch at the base of the tower. Having a large transformer up-tower in the nacelle creates serious working space issues. Additionally, setups like this necessitate long vertical drops of 34.5kV cable running in close proximity to the service ladder (**Photo 2**). It also means even more critical strain relief techniques for medium-voltage cables than are required for low-voltage cables.

Worker safety issues

When hiring turbine technicians, most wind turbine companies tend to focus on the prospective employee's previous mechanical skills. Indeed, that is the skill set workers need more often for turbine maintenance. Although electrical troubleshooting and maintenance make up much less of a wind turbine technician's routine work activities than you might think, even the most fundamental electrical troubleshooting is high risk. Despite its low frequency, the high severity of an electrical accident in this work environment produces a high risk.

As a result, lack of electrical background in this industry can be lethal. Here's just one example. One inadequately qualified turbine tech was fatally burned by the plasma blast he created when he mistook a tap changer for a load break switch. He was in the process of de-energizing a 2MVA transformer for a routine maintenance shutdown when this horrific accident occurred.

In addition to NFPA 70E training, our company conducts arc flash hazard analyses for wind farms. If we hadn't had the physical evidence from previous multiple wind farm accidents, we would probably have had a hard time believing the off-the-charts magnitude of the incident energy levels our software was spitting out (click here to see **Photo 3A**) and (click here to see **Photo 3B**) . These studies have confirmed the obvious: Potential incident energy on most wind farms is extremely dangerous.

Code violations illustrated

The hazards and installation problems are not just confined to explosive levels of incident energy. As a retired electrical inspector, I see numerous NEC violations "down on the farm." One of the first questions I generally ask my contact person on a wind farm is, "Who is the AHJ responsible for inspecting your turbine and tower installations?" More times than not, I get the same, strikingly consistent, shrug of the shoulders. In other words, they have no idea.

Photo 4. This is a clear violation of the access and egress requirements of the NEC. The Code requires a "continuous and unobstructed way of egress travel."

This raises another issue. Does NFPA 70 and 70E apply to wind farms? NFPA purists might contend that because many wind farms "are on property owned or leased by the electric utility for the purpose of ...generation, transformation, transmission, ... of electric energy," as stated in NFPA 70 and 70E 90.2(B)(5)c, these standards would not apply. Such purists would defer to the more performance-oriented National Electrical Safety Code (NESC) published by the IEEE. However, because the NFPA 70 and NFPA 70E are somewhat more prescriptive than the NESC, most wind farm companies have chosen to use all three standards. Ultimately, wind farms must comply with OSHA. Adopting NFPA's consensus standards and IEEE's NESC provides the best chance for OSHA compliance.

Photo 5. Does this say adequate working space to you? This containment vessel is both a shock and trip hazard. According to 110.26(A)(3) of the NEC, "... The work space shall be clear and extend from the grade...".

Unfortunately, enforcement of these standards can be lax. As a result of this apparent lack of oversight, I have encountered NEC violations that make me cringe. The most shocking offenses tend to do with egress requirements (**Photo 4**). On several tower designs, switchboard enclosure doors are hinged such that they open across the only exit path out of the tower. Having personally witnessed the excruciating death (not on a wind farm) of an electrical worker in large part because of inadequate egress, I'm especially vigilant about this violation of NEC requirement 110.26(C).

Photo 6. Do the requirements of the NEC or the NESC apply to this 650-strand DLO-type cable?

Another NEC violation I've seen (**Photo 5**) is the intrusion into the work space [NEC 110.26(A)(1)] by containment walls for the step-up, oil-filled, pad-mounted transformers at the base of most tower configurations. A critical work procedure is performed in the 34.5kV side of the transformer — protective grounding. The darkly tinted arc flash hood worn during this operation makes the containment wall, if placed too close to the enclosure opening, an especially worrisome trip hazard.

DLO-type cable is commonly used throughout wind farm power systems. As shown in Photo 6 on page C34, there was no lug labeling at this location stating this 650-strand 262.6kcmil cable could be terminated on this particular breaker. This appears to be a violation of Secs. 110.3(B) and 110.14 of the NEC. A new sentence has been added to 110.14 in the 2011 edition of the NEC that states, "Connectors and terminals for conductors more finely stranded than Class B and Class C stranding as shown in Chapter 9, Table 10, shall be identified for the specific conductor class or classes." However, the 650-strand conductor shown in Photo 6 does not fit into any of these classes.

Induction problems

Photo 7. The lack of slotting or larger openings with insulating walls will induce circulating currents on the ferous metal enclosure wall that could potentially produce insulation damaging heating.

The conductors in Photo 7 are not grouped as required by 300.20(B) of the NEC. As noted in this section of the Code, "Where a single conductor carrying alternating current passes through metal with magnetic properties, the inductive effect shall be minimized by (1) cutting slots in the metal between the individual holes through which the individual conductors pass or (2) passing all the conductors in the circuit through an insulating wall sufficiently large for all of the conductors of the circuit." By not having all the phases of a circuit grouped through a common opening in a ferrous metal enclosure, circulating currents will be induced in the metal enclosure. This could potentially produce enough heat to damage the conductor insulation where it passes through the hole.

What does the future hold?

One of the biggest contributing factors leading to this lack of oversight is the complexity of the business model for this industry. Much of the equipment is manufactured in other countries, which makes it non-compliant with U.S. standards. Also, because of the typically remote locations of wind farms, installation and tower construction are done without the benefit of building permits. Even if local jurisdictions chose to inspect such installations, it is doubtful they would have the technical experience to adequately enforce applicable codes.

Multiple layers of ownership and liability further complicate matters. In some instances, responsibility for worker safety falls to multiple employers. In fact, the responsible party for safety is often split between the tower owner, the contractor responsible for "balance of plant" equipment, and the maintenance contractor who maintains the low-voltage equipment up to and including the turbines.

At one of my recent presentations on this subject, I found my audience was largely made up of insurance company representatives. During the Q&A exchange, they expressed a consensus of concern about how to insure this emerging sector, confirming my suspicions about a lack of oversight. They expressed a general sense of agreement that the wind industry's chain of command and layered ownership make their risk/responsibility assessment difficult.

I tell the turbine technicians in my classes that I've got good news and bad news. The bad news is you have elected to work in one of the most potentially dangerous electrical workplaces on the planet. The good news is if you take the proper precautions — and really understand the design of these systems — you can expect a long and worthy career ahead of you.

Kardon is a consultant with Code Check Institute in Philadelphia. He can be reached at redwood@codecheck.com .

Source URL: https://www.ecmweb.com/contractor/don-t-call-them-windmills

ANALYSIS OF WIND TURBINE GROUNDING SYSTEMS

M.I. Lorentzou, N.D. Hatziargyriou, Senior Member, IEEE, B.C.Papadias, Fellow IEEE

Abstract

In this paper, the response of windturbine grounding systems is calculated under fault conditions or when they are hit by lightning. The objective is their effective design in terms of dispersion of imposed currents and minimization of raised potentials. Locally raised potentials are calculated in terms of steady state GPR. Transferred potentials to neighboring windturbines are also computed. Measures taken to reduce potentials are presented and commented. For the purposes of this paper the well-known software packages EMTP (Electro Magnetic Transients Program) and CYMGRD (CYMe's GRounDing) have been used.

Index terms: *wind turbines, windfarms, grounding, lightning strikes, EMTP-modeling, effective length.*

1. INTRODUCTION

Windturbine grounding system has to be effectively designed in order to prevent excessive overvoltages and potential gradients that may cause damage to equipment or threaten human life. Fault or lightning currents to any windturbine in a windfarm installation, may damage equipment directly or indirectly as transferred potentials may exceed allowed values at windturbines in the neighborhood of the fault.

Windfarms are usually situated in rocky and mountainous areas where the wind potential is high[1],[2]. In these areas soil resistivity also has high values. For this reason difficulties arise when designing grounding systems of windturbines in terms of reduction of touch and step potentials and minimization of grounding system resistance.

The area that the grounding system takes is often limited by topographical factors. For this reason practical problems arise, as the area which is practically available is smaller than the one required for correct dimensioning of the grounding arrangement. Installation costs also increase for ground rods installation in highly resistive soil. (Use of special equipment).

In case of extended grounding systems i.e. when windturbine grounds are interconnected, the effect of "effective length" of interconnection conductors is analyzed and investigated. Its effect on lightning surge analysis is very important as it weakens the effect of adding more material in order to reduce grounding resistance.

For the purposes of this paper, existing software packages as CYMGRD[3], and EMTP[4], suitable for grounding system analysis, have been used in order to calculate grounding resistance and touch and step potential values. Analysis using the software program CYMGRD is based on finite element method, and division of the grounding system into elementary segments. EMTP is mostly used in computation of the transient response of grounding arrangement. By extending its capabilities for transmission lines calculations [5] it has been effectively used for grounding systems analysis.

Particular methods followed in order to reduce maximum voltages observed are presented. Alternative grounding system design techniques are also presented and discussed. Various methods to minimize touch and step voltages are examined for their effectiveness.

According to current international Standards the following definitions apply [6]:

- *Ground Potential Rise (GPR)*: The maximum voltage that a station grounding rid may attain relative to a distant grounding point assumed to be at the potential of remote earth.
- *Touch Voltage* is the potential difference between the ground potential rise (GPR) and the surface potential at the point where a person is standing, while at the same time having his hands in contact with a grounded structure.
- *Step Voltage* is the difference in surface potential experienced by a person bridging a distance of 1 m with his feet without contacting any other grounded object.

2. SAFETY CRITERIA

Safety criteria that have to be met are set according to International Standards. There is a difference in regulations that apply in case of short circuit analysis [6] and in case of analysis of lighting response [7]. More particularly it is:

2.a Lightning strikes

Grounding resistance of WT arrangement or WT connected to the local transformer grounding system is required to be below or equal to 10 Ohms. This is the only requirement being suitable for lightning protection. A resistance of 10Ω or less (before it is connected to any other system) is stated in international standards/recommendations. When the system is concentrated, or when it takes a small area, raised

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Athens 157 73, GREECE.

potentials are equal to those produced by an AC current of the same magnitude.

2.b Short circuit

In case of short circuit the step voltage safety limits are determined using IEEE Guide [6]. For calculations of grounding arrangements in this paper the following parameters values are taken:

Soil resistivity = 400 Ωm / 600 Ωm.

Human Weight = 50 kg

Shock Duration =0.02 sec - 0.10 sec

Table 1: Maximum Allowable Step Voltage

Soil Resistivity / Shock Duration	ρ_s=400 Ωm	ρ_s=600 Ωm
0.02 sec	3885 V	5273 V
0.03 sec	3172 V	4305 V
0.10 sec	1737 V	2358 V

Touch potentials safety limits are used to determine the area where a man in contact with the grounded structure can safely stand. Practically, it is very rare for a working person close to a WT grounding to experience high touch voltages because the area surrounding WT tower is usually safe. It is also suggested to place a fence surrounding the safe area.

3. FUNDAMENTAL DESIGN OF WT GROUNDING

The grounding of a single wind turbine is normally achieved by placing a ring electrode around the foundation and bonding it through the foundation to the turbine tower.

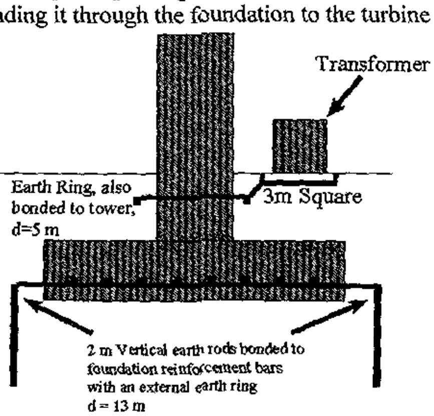


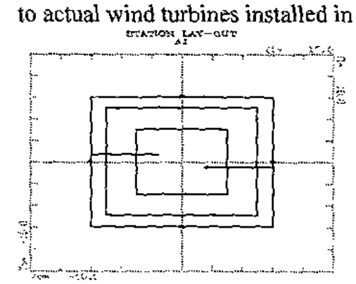
Figure 1

The foundation reinforcement bar is also connected directly or via the turbine tower to the ring electrode and will be effective in acting as a ground electrode since the surrounding concrete can be considered to have a resistivity equal to that of the surrounding soil. However, in relevant calculations it is normally ignored to provide a worst case analysis of the grounding system. Vertical rods or strip electrodes (horizontal electrodes) are often used in conjunction with this ring electrode to achieve a certain value of ground resistance. Furthermore, ring electrodes of gradually increasing depth and diameter may be added in order to reduce touch and step voltages at the edges of the system.

Dimensions shown in figure 1 are common for windturbines in the range of 600kW as for practical reasons grounding system dimensions depend closely on the WT foundation dimensions.

4. INDIVIDUAL WIND TURBINE GROUNDING

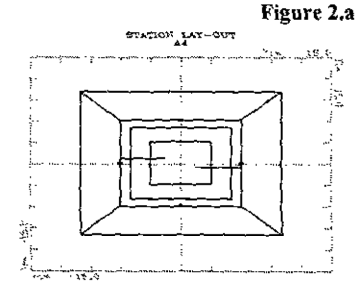
Grounding resistance of WT arrangements as shown in fig.1 have been calculated. These arrangements correspond to actual wind turbines installed in Greece.



Case 1
ρ_{soil}=400 Ω-m
R=13.0538

Case 2
ρ_{soil}=600 Ω-m
R=19.5806

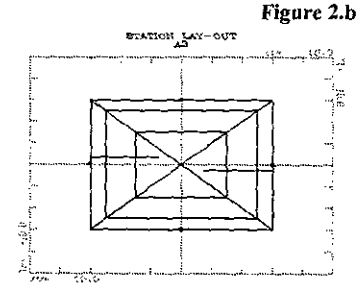
Figure 2.a



Case 1
ρ_{soil}=400 Ω-m
R=8.8966

Case 2
ρ_{soil}=600 Ω-m
R=13.3449

Figure 2.b



Case 1
ρ_{soil}=400 Ω-m
R=12.8046

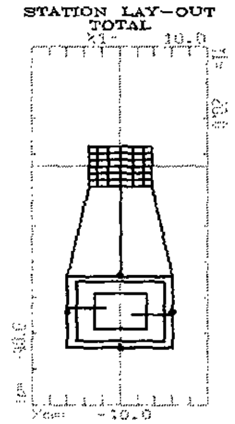
Case 2
ρ_{soil}=600 Ω-m
R=19.2068

Figure 2.c

It can be observed that the area taken by the grounding system following an inverse square law mainly reduces grounding resistance. Furthermore, increasing the depth there is no important decrease in grounding resistance.

The WT grounding arrangement is usually connected to the local transformer grounding. This makes use of the existing path for the connection between the WT tower and the transformer, lowering the total grounding resistance. This is shown in figure 3.a where local transformer grounding has been connected to WT grounding using three conductors. In order to reduce grounding resistance, a large grounding arrangement has to be installed as shown in fig.3.b.

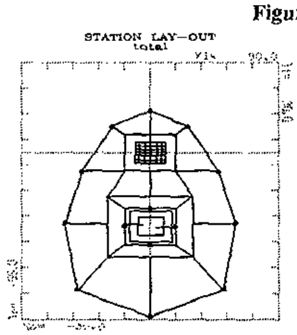
Step potentials along the y-axis are plotted in fig.4.a for the arrangement of fig.3.a and in fig.4.b for the arrangement of fig.3.b. A serious decrease can be observed at fig.4.b and safety criteria (horizontal lines) given from Table 1are met in most of the points close to WT.



Case 1
ρ_{soil}=400 Ω-m R=8.6485

Case 2
ρ_{soil}=600 Ω-m R=12.9726

Figure 3.a



Case 1
ρ_{soil}=400 Ω-m R=3.9851

Case 2
ρ_{soil}=600 Ω-m R=5.9776

Figure 3.b

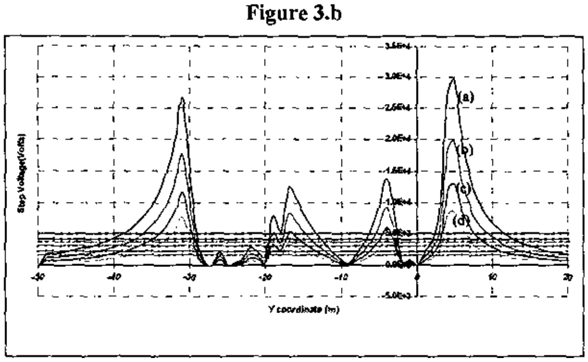


Figure 4.a: Step Voltage along the y-axis for injection of i) (a),(c) 16 kA or ii) (b),(d) 7 kA

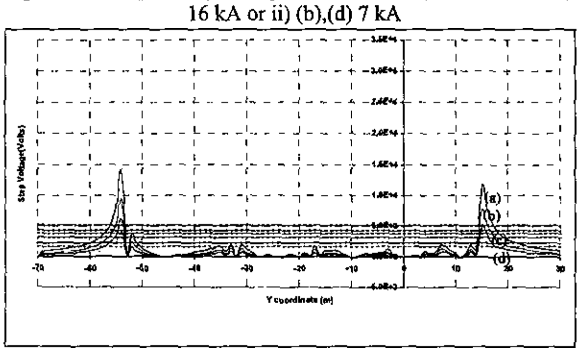


Figure 4.b: Step Voltage along the y-axis for injection of i) (a),(c) 16 kA or ii) (b),(d) 7 kA

In general, increasing the depth of the grounding installation lowers the produced values of raised touch and step potentials. Rings or closed type curves of gradually increased depth and diameter are used to eliminate raised potentials.

5. WINDFARM GROUNDING (-EFFECT OF INTERCONNECTIONS)

5.a. Fault Conditions – Low Frequency Response

The individual wind turbine grounds are in some cases connected by the metallic screen or armour of the main power cable running between the turbines. In this case power cable is considered as part of windfarm grounding system. This has the effect of reducing the overall site ground impedance to a low value, often 1-2Ω when a low frequency response is calculated or measured.

The following example of two connected WT arrangements shows how drastically grounding resistance and step voltages are reduced. Safety limits are met in almost all cases.

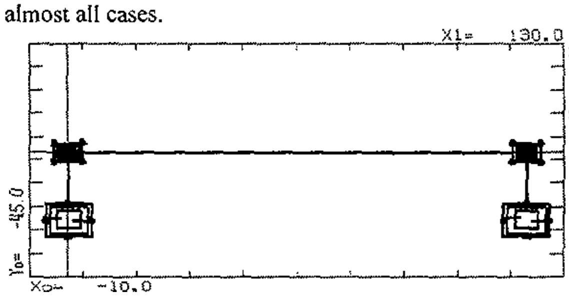


Figure 5.a

Grounding resistance values are:
When ρ_{soil}=400 Ω-m R=3.5758
When ρ_{soil}=600 Ω-m R=5.3636
Step voltages along the y-axis of WT are plotted in fig.5.b

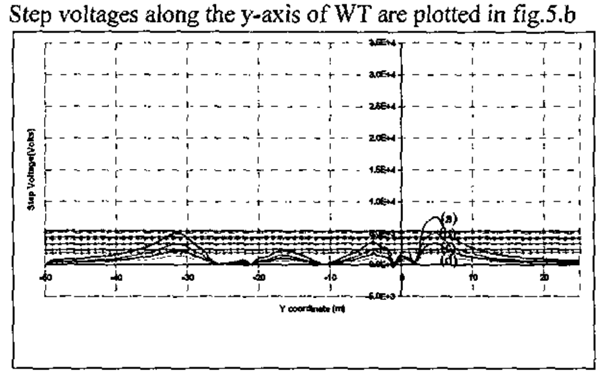


Figure 5.b: Step Voltage along the y-axis for injection of i) (a),(c) 16 kA or ii) (b),(d) 7 kA

Low frequency response of windfarm grounding system shows that it is beneficial to interconnect WT grounds. However when the windfarm is sited in an area of high soil resistivity or in mountainous area installation of an underground power cable is practically difficult. In similar cases in Greece overhead lines are used instead of power cable.

5.b. Lightning Strikes – High Frequency Response

A lighnting current that hits a single WT is dispersed in the earth, producing a max GPR as if windturbine grounding system was replaced by a resistance. This is explained by the fact that single WT grounding arrangemet is concentrated in a small area so its reactive component can be neglected even in high frequencies. When an extended grounding system is examined, as in the case of windfarm with interconnected WT grounding systems the reactive component is important at high frequencies. Consequently the overall impedance in case of lightning is much greater that the grounding impedance in case of short circuit.

The effect of interconnection electrodes determines the overall impedance that sees the impulse lightning current when it hits a WT. Their effective length value limits their contribution to the reduction of the impedance to an upper value. Effective length is the length value above which, no considerable reduction of the impedance of the electrode is observed, when increasing the length[8]. It is dependent on frequency and soil characteristics. An example of this fact is given in fig. 3.where the max. GPR produced by a 9kA 1.4/17μs impulse current strike and also by a sinusoidal 9kA*sinωt current source has been plotted using EMTP.

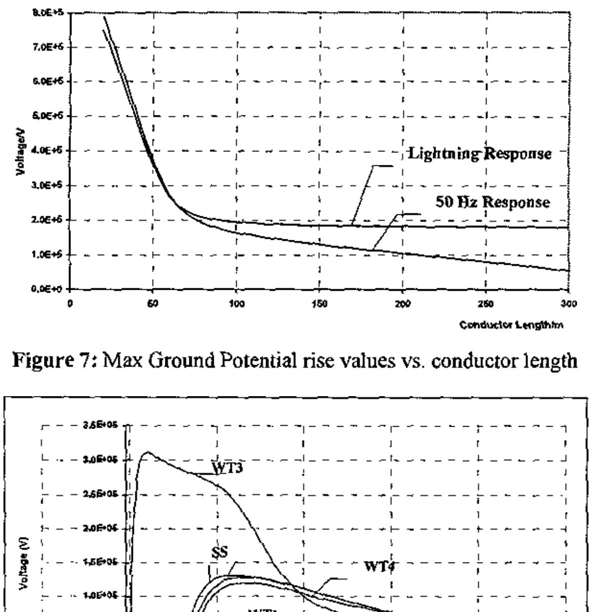


Figure 7: Max Ground Potential rise values vs. conductor length

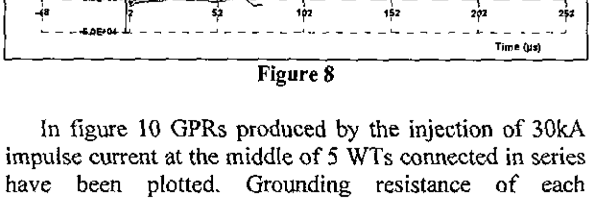


Figure 8

In figure 10 GPRs produced by the injection of 30kA impulse current at the middle of 5 WTs connected in series have been plotted. Grounding resistance of each windturbine base is equal to 24.8 Ohms. Consequently impulse current injection at a single WT would produce a max GPR equal to 744 kV. If the reactive component is neglected, the same impulse current at the middle of 5 interconnected WTs would produce 150kV. In this case the max GPR at the injection point is equal to 311440V.

Transferred potentials to neighboring WTs in case a lightning current is injected are larger than in case of short circuit. This is due to the grounding system reactance.

6. CONCLUSIONS

In this paper existing software packages have been used to calculate the response of windturbine grounding system under short circuit of lightning current injection. The scope of the analysis is the effective design of grounding arrangement in order to minimize raised potentials and total system grounding resistance.

In case a windfarm is examined, then suitable calculations are needed in order to decide if it is better to interconnect windturbine grounding arrangements.

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Preparing turbines for lightning strikes

By Michelle Froese | May 14, 2018
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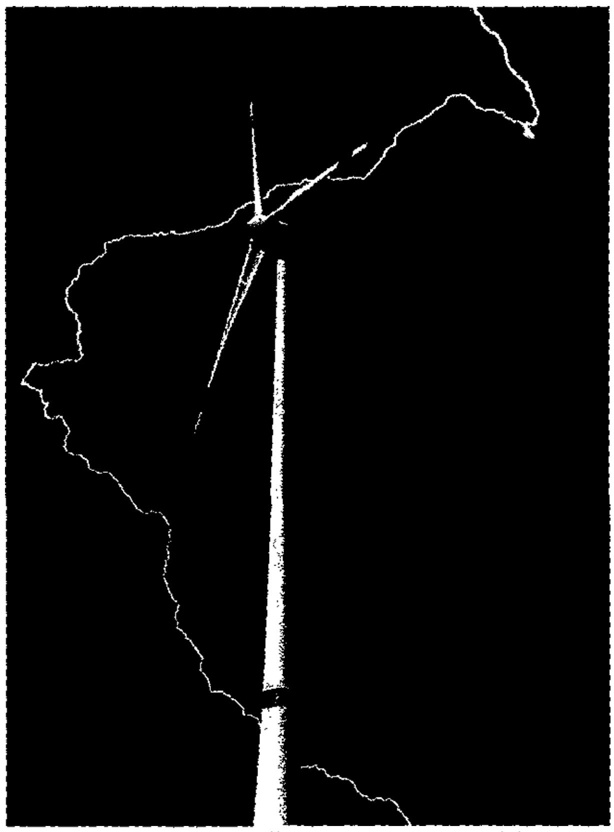
By Michelle Froese, Senior editor
Windpower Engineering & Development



There are over 1,700 electrical storms active throughout the world at any time producing over 100 flashes per second. This equates to some 7 to 8 million strikes per day, which means your wind farm is at risk. Preventing direct and near-strike damage to wind turbines is critical to decreasing downtime and extending reliable turbine performance.

The average energy released in a lightning strike is 55 kWh. Understandably, most wind owners and operators breathe a sigh of relief when a major storm passes their wind farm without damage to a turbine. However, measurements have shown that lightning strikes may hold more power than initially calculated, and that large strikes can be multiples of the average. This means a powerful lightning strike could be 20 times that of an average one.

"Lightning is a serious concern for wind-farm owners," shares Daniel J. Sylawa, Business Development Manager with Phoenix Contact. "But it is rarely discussed in detail or at length because lightning protection and management is something that's generally considered an OEM responsibility."

Sylawa says manufacturers typically equip wind turbines with some form of basic lightning protection that uses grounding down conductors in the blades and grounding systems in the turbine. "Depending on the OEM, you'll find different types of lightning receptors on the turbine blades, which are then connected to the nacelle via brushes or a spark gap that lets lightning conduct to a good firm ground."

In addition to lightning protection, surge suppression is a critical turbine safeguard that mitigates lightning or static effects. "Even without the risk of a direct strike, turbine blades rotate through the air to capture and generate energy," he says. "Essentially turbines are large static machines, so surge protection is essential and should be found on the pitch control, tower electronics, inverter, and control system to protect against component failure."

Most wind-farm owners are aware of the benefits of a quality surge and lightning protection system. However, lightning risks may vary greatly from one turbine to another at a wind farm.

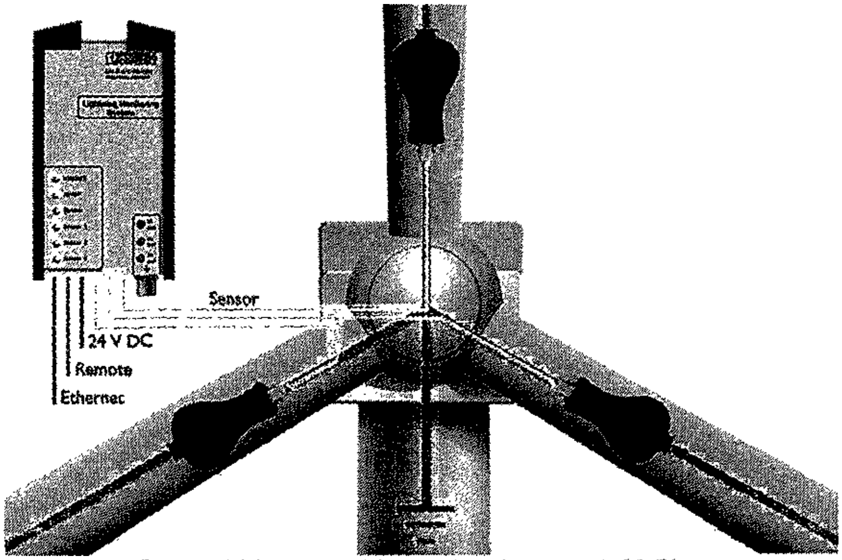
"Unfortunately, these assets are often purchased en masse," says Sylawa. "So unlike buying a new car where you may pick the model and specific features, buying a wind farm typically involves a less detailed selection. The developer agrees to buy a project under a set PPA with a specific number of turbines. And those may very well come from several different manufacturers."

This scenario means a wind-farm operator may face challenges in optimizing a fleet. "To optimize production and ROI, a wind farm has to run as a unit. It is an electric power plant. But if one part of that plant is generating at less than full capacity or facing downtime, that puts the whole plant at risk of lost production."

Near strikes

There are tools available that may offer protection to a wind farm. For example, weather-measurement systems use metrological data to predict the probability of a lightning strike in a given area. Lightning sensors installed at wind sites perform a similar function but use local measurements to determine the location of a strike.

These systems may provide an extra measure of support, but they are unable to tell if a turbine is directly impacted by lightning. While a direct strike may be obvious to an O&M team, near strikes are a different story. Near strikes are indirect hits that can occur from several miles away. In most cases, near-strike damage is invisible from the ground and may go unnoticed during routine ground-level inspections.



Phoenix Contact Lightning Monitoring System (LM-S) use sensors based on the Faraday Effect to provide a more comprehensive range of lightning data to manage assets. Polarized light is rotated through a magnetic field over a defined length and measured. When mounted on a turbine blade's down conductor, an external magnetic field is generated by the lightning current, which travels down the conductor and rotates a light beam proportional to the current amplitude. The LM-S lightning current measuring system can detect, evaluate, and remotely monitor lightning strikes in real-time.

"Lightning would be somewhat easier to manage if all strikes were centered directly on a target, but Mother Nature is much less predictable than that," says Sylawa. "Near strikes are offshoots of lightning that can lead to serious problems — problems that may go undetected or simple not present as such for some time after striking."

One example is damage to a turbine's blade material. A near strike may cause a small fault in the blade's substrate material, which may go unnoticed until rain seeps in and eventually results in water damage. "When winter hits, a freeze-thaw cycle can also expand and degrade the under-grading material and lead to blade failure," he adds.

Another example is secondary lightning effects, which may cause electromagnetic pulses or surges that can damage electronics inside a turbine or substation.

"I was recently in talks with one turbine manufacturer who is working to increase the requirements for surge protection for their electrical system and components because of damage from secondary lightning effects. So OEMs are certainly cognizant of these effects and the need for high-quality surge and lightning protection."

Setting up safeguards
Wind turbine or blade damage can occur for many reasons: wear, debris, precipitation, operational errors, manufacturing defects, lightning strikes, and others. Early detection and mitigation techniques are necessary to avoid or reduce damage.

However, what happens when a near strike causes delayed onset damage such as nick in a blade that only becomes detectable over time?

"This can be a big warranty issue," says Sylawa. "If an area had been hit by a storm, experts may try to decipher whether damage is from lightning or from workmanship and material defects. In some cases, near-strike damage cause may prove challenging to substantiate."

What can a wind-farm operator do to protect their assets and warranty? Sylawa has some suggestions.

Recognize the risk
"Most wind-farm operators opt for some type of weather service, or have some form of lightning detection." He says the most common are direct-measurement systems such as strike counters, which are surge-counting devices, and card sensors. The card sensors attach to a turbine's down conductor and measures the peak current that traveled down that conductor during a strike. "Ideally, an effective lightning measurement system detects a variety of risks.

Inspect, inspect, and inspect some more
A quality surge and lightning protection system is one key to a profitable wind farm. An excellent O&M plan is another. "There are inherent risks in operating a wind plant even with the best protection. The number one thing a wind-farm operator can do is implement high-level inspections because, at the end of the day, you cannot fully know what the effects of lightning are on turbines."

Sylawa adds that it is important to look beyond the surface of the turbine during O&M calls. "After a lightning strike, a wind tech may not find noticeable damage to the tower or blades and think everything is fine. But it's extremely important to go through and test the electrical system. A turbine may have a tripped or blown surge suppressor that's impossible to notice with an inspection."

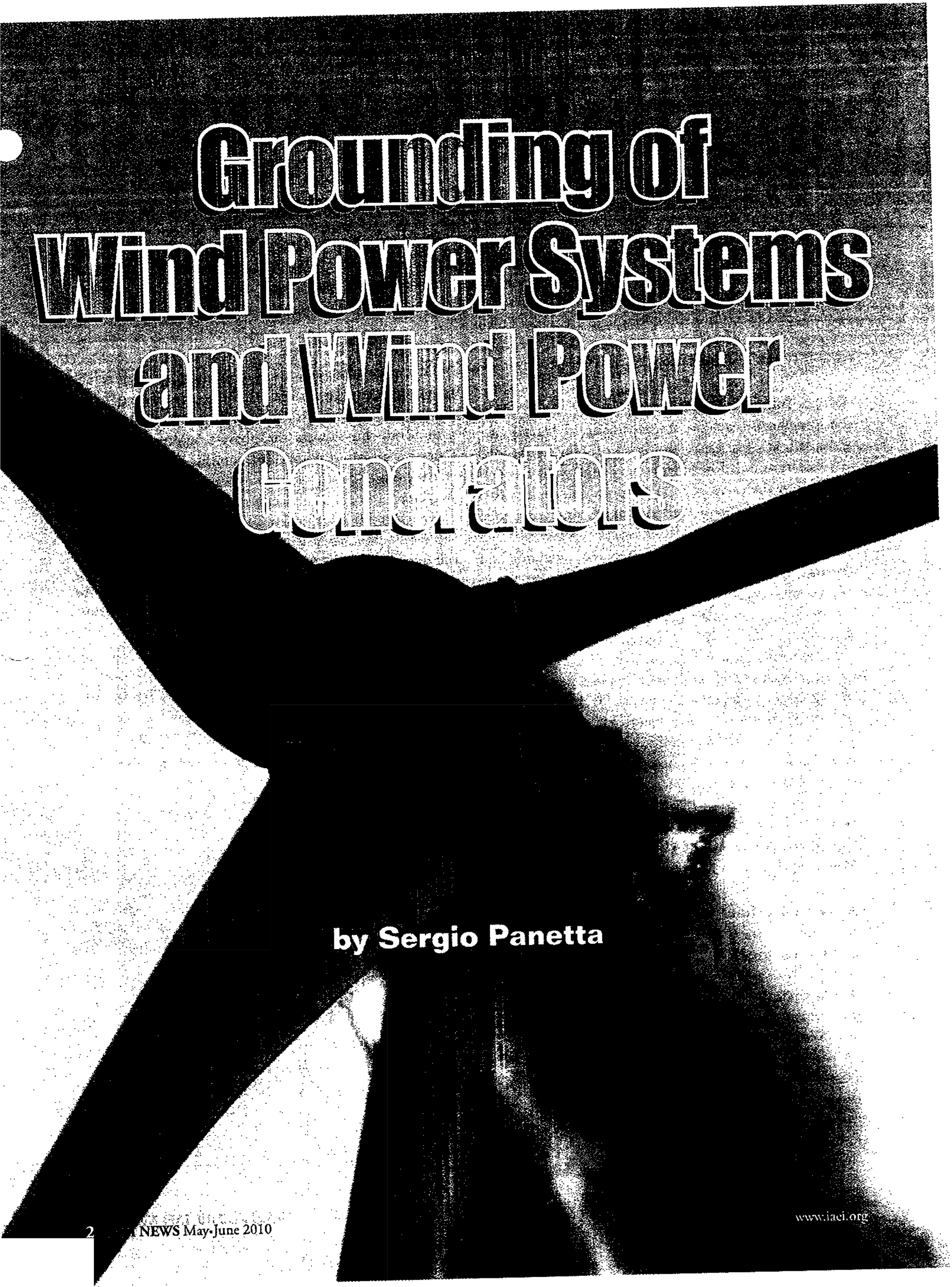
Condition monitoring for blades
Lightning detection sensors are not new, but advanced turbine and blade lighting detection systems that connect remotely to data centers can measure and provide greater insight. For example, they can provide asset monitoring, predict maintenance issues, and send event notification — such as strike warnings.

"Wind power is moving toward a smarter, more data-driven industry," says Sylawa. "Sensors can now record information for a wind owner or operator remotely, and in seconds they'll have access to a full analysis of what's going on for a specific turbine or blade in that turbine." Such data could potentially also support warranty claims.

"Wind owners who have access to big data, which helps determine the health and status of their assets, will be ahead of the O&M game."

Grounding of Wind Power Systems and Wind Power Generators

by Sergio Panetta



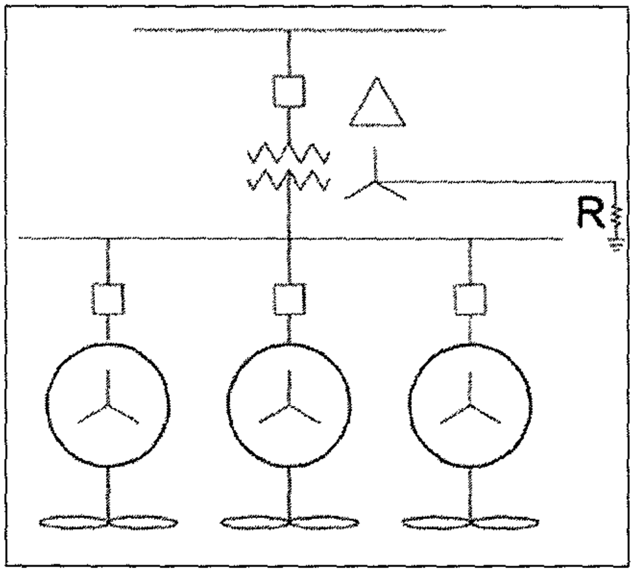


Figure 2. Multiple generators connected to transformer

MV Electrical Distribution Networks

Wind farm collection networks are simple radial circuits with switching devices for isolation and switching [1]. Balanced 3-phase networks are suitable for connecting large wind generators. The secondary of the generator step-up transformer can be Y- or Delta-connected. In Y-connected transformers the neutral point is directly accessible and hence can be easily grounded. In Delta-connected transformers an accessible neutral point is created by using a grounding transformer as shown in figure 4. The usual practice is to ground the neutral point at one location only.

Electrical Protection

With high-resistance grounding of the generator step-up transformer, fast acting ground-fault relays can be applied in the generator circuit. Low-resistance grounding by neutral grounding resistors or artificial neutrals is suggested for the MV network. The fault currents in the MV collection networks can be small due to high source impedance and long lengths of cables. In some cases, fuses cannot be relied upon to quickly clear the fault; hence, ground-fault relays and circuit breakers are required. It is important to isolate the faulted section quickly. Correct discrimination is obtained by the application of ground-fault relays.

Additional Electrical Protection

California reports 35 turbine generated fires per year due to short circuiting and lightning. A single turbine may contain up to 200 gallons of oil; the transformer at the base of each turbine may contain another 500 gallons of oil. In rural areas even a spark can easily develop into a large fire before discovery is made and fire-fighting can begin. [5] These fires may be avoided and save millions of dollars in damage by placing arc flash mitigation relays in the switchgear in the nacelle. On the occurrence of an arc, the turbine can immediately switch off-line and reduce damage, protecting the personnel, equipment, and the environment.

Conclusion

Ungrounded delta systems have many operating disad-

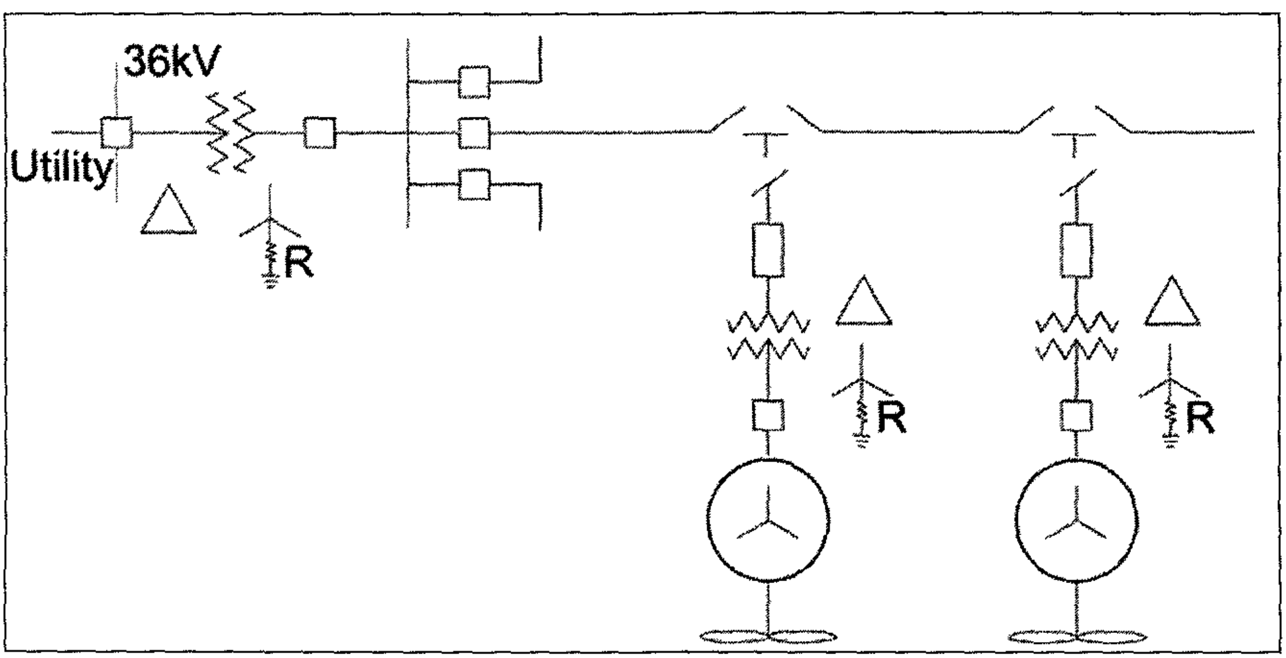


Figure 3. MV Collection Network

Stray voltage: The silent killer

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November 26, 2018
By Patrick J. Lynch

November 26, 2018 - One winter morning in early 2004, PhD student Jodie Lane was walking her dogs through the slushy sidewalks of New York City when all of a sudden, without any warning, both she and her dogs were writhing in pain, hit by an invisible force. A metal sidewalk plate had become energized at 57 V, due to the corrosion and insulation failure of an antiquated and poorly maintained wiring system beneath it.

Passersby attempted to help Jodie, but they got shocked. Two local foot-patrol officers were quickly called to the scene, but after one of them was shocked too, the other cordoned off the area with yellow 'do not cross' caution tape.

Staff from a local store raced over in rubber gloves and with wooden mop handles in an attempt to push Jodie away from the metal plate, but first responders blocked them from helping and even threatened to arrest them.

It took more than 20 minutes for Jodie to die. Onlookers continued to plead frantically with the first responders to help her in her final moments, but all they would do was watch the tragedy unfold, safely from behind the yellow tape. Eventually, an electrical utility crew showed up and turned off the power, so an ambulance crew could remove Jodie's body.

Jodie's father, Roger, successfully sued the utility for $7.2 million and used the money to set up an education fund at her university and a public safety foundation in her name. One of the conditions of the settlement was that the utility had to make public a city map detailing all stray voltage locations. In this process, more than 34,000 locations were uncovered across the city!

The electrical and political problems uncovered in New York are not unique; they are also occurring in other major cities across North America with aging infrastructure, including Vancouver, Toronto and Montreal, where dogs have been killed or injured by electrified sidewalk plates.

Yet, these street shocks are still often referred to as 'freak accidents' or 'isolated incidents.' This has allowed municipal governments to dismiss the existence of stray contact voltage in their cities.

To combat the problem, private electrical testing companies have emerged that use high-tech equipment to scan pedestrian-accessible areas and correct any stray voltage conditions they find. Some utilities are asking for this testing to be performed at least twice a year.

How it happens
Stray voltage occurs when an electrical current moves from flowing within an electrical wiring system to another conductive object, such as a metallized water piping system, a steel structure or a concrete floor, and then through a person or animal who comes into contact with it.

By way of example, a bus shelter with electrically powered billboard advertising on the side was found to be energized with 120 V throughout its steel structure. Shortly after it was tested, the utility dug up its feeder and fixed the incorrectly wired installation.

Dangerous when wet
Marinas and swimming pools are also prone to stray voltage issues. One yacht club's marina was tested to find more than 15 A of stray current flowing in the water between the boats; it takes less than 0.1 A to stop your heart! Concerned more with liability than with fixing the problem, the club's directors simply installed 'no swimming' signs.

When professional engineers closed a community swimming pool where children had received electrical shocks, the mayor attempted to reopen it prematurely for a scheduled swim meet. Some politicians do not understand how life-threatening stray voltage can be!

More recently, a new water park was built directly beneath a 27,000-V electrical distribution feeder. With a high-voltage electrical pole mounted within a few feet of the water's edge, it appeared to be an accident waiting to happen, though it was apparently built to current electrical codes.

Faulty concentric neutrals on high-voltage underground cables created stray voltage in a U.S. lake, resulting in death for one swimmer and brain injuries for two others. The electrical utility was successfully sued in civil court, but refused to fix the problem, leaving cottage owners unable to sell their properties after the highly publicized event. A similar stray voltage situation also shocked a young swimmer in a lake in Southern Ontario.

Shutting down farms
While dogs on sidewalks and swimmers in cottage country have made headlines, cattle on farms have been dying from the effects of stray current and voltage for at least the past 40 years. Indeed, thousands of cattle have been adversely affected.

Dairy cows are extremely sensitive to electricity. Generally, they will start to notice currents flowing through their bodies at levels between 0.001 and 0.002 A and subsequently produce less milk each day, as well as suffer additional health problems, such as mastitis. At higher levels, they may die.

In Wisconsin in 2008, a dairy farmer successfully sued an electrical utility for $2.3 million over the stray voltage issues from which his cattle had suffered for at least 20 years. He went on to publish a book outlining not only the court case, but also the surrounding electrical technical issues, for other farmers to use as a reference guide.

In some of these cases, dairy farmers sell off their remaining cows and start planting crops on the land instead. One of them, based near Woodstock, Ont., claims he has lost more than 100 cows and $1 million due to utility-based stray voltage issues that have been confirmed by electrical engineers.

In a recent investigation, a farmer spent more than $100,000 to hire five different electricians over four years to solve his stray voltage problems. He found his cows were reluctant to drink at watering troughs or enter automated milking machines. His milk production was reduced by more than 40%.

As he tearfully prepared to sell his dairy farm to cover his financial losses, however, another site investigation led to remedial work, which managed to reduce stray current at the farm from 10 to 15 A to a constant, steady-state 0 A and stray voltage at the troughs and milking machines from 2.5 V to less than 0.02 V.

His farm had experienced a wide range of deficiencies, including main incoming power supply connection issues at the electrical panels, melted neutral/ground wiring systems, electrical equipment contamination, defective lighting systems and submersible heater dielectric insulation failures. Fortunately, all of these issues originated from equipment that could easily be controlled and corrected. Any off-farm stray voltage would have to be corrected by the utility, which is generally an extremely complex, expensive, political and time-consuming process.

A monitoring and data logging system was custom designed and permanently installed at the farm, so as to instantaneously capture and record any future stray current. When wiring or equipment fails, it can be electrically isolated immediately and replaced quickly, without adversely affecting milk production.

General recommendations

If an electrical circuit fails on the 'hot black side,' it will normally trip a circuit breaker when that breaker's fault current threshold level has been exceeded. It is important to investigate, repair and replace the circuitry as soon as the problem occurs.

At shore-power marinas, ground fault interrupters (GFIs) should be installed on all circuits, not just the low-amperage electrical feeders. Both GFIs and stray current monitoring equipment should be installed at all community swimming pools.

Going forward, regular scanning for stray voltage in electrical utility infrastructure systems will need to become mandatory and be strictly enforced by independent policing agencies. And if a problem is found, it should be quickly corrected by the utility before anyone else suffers from it.

The utilities should examine alternative electrical distribution designs. SaskPower, it should be noted, appears to be the first in Canada to require a four-wire service drop for new residential and agricultural customers, which is a step in the right direction. Further, SaskPower recommends the installation of a bond wire between agricultural buildings to establish an equipotential plane, with the neutral bonded only to ground at the transformer or weatherhead, to prevent the ground or bond wire from carrying any current. In California, meanwhile, special electrical utility high-voltage systems designed for farming areas have yielded the 'happy dairy cow' designation.

Electrical failures on the grounded or neutral side of a standard system can generate extremely high levels of stray current. Indeed, the equipment may work perfectly, leaving the problem undetected for years until something abnormal happens.

A recently investigated hospital room, for example, had more than 30 A of stray current flowing through it for at least 15 years. A portion of that current would have affected every patient who was operated on within the room!

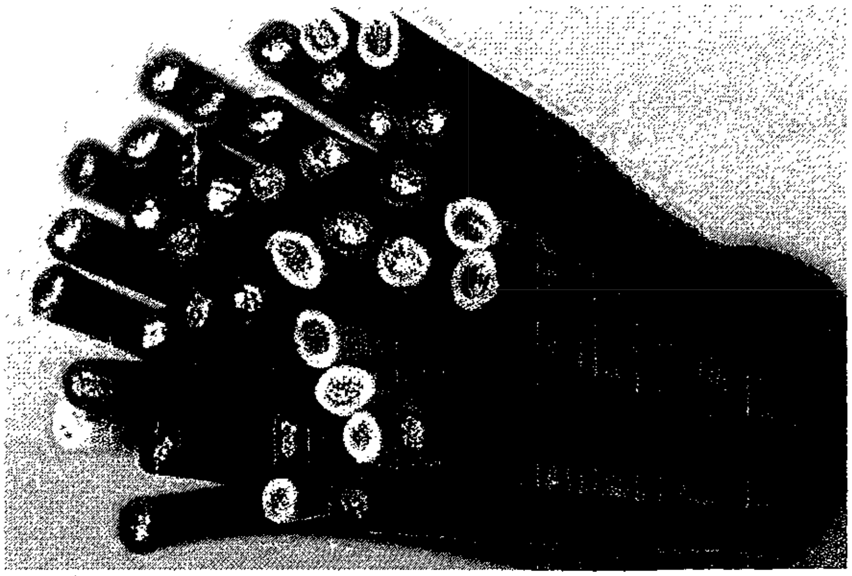
The costs to society

As illustrated in such examples, stray voltage can sneak into many areas. Electrical equipment will corrode over time and, particularly with outdoor exposure, can fail.

Recommendations for fixing such problems will cost money, raising issues of politics, shareholder returns and legal liability, but how much is each Jodie Lane's life worth? How much is a child's life worth at a lake, swimming pool or water park? What is the cost to society when farms are shut down?

It would appear we are now moving in the right direction, but at a snail's pace. I believe we may still be facing some of the same types of stray current and voltage issues for the next 40 years or more.

Five common causes of electrical fatalities



October 10, 2013

KEYWORDS electrical hazards /electrocution
Reprints

Almost all American workers are exposed to electrical energy at sometime during their work day, and the same electrical hazards can affect workers in different industries. Based on the analysis of these cases, NIOSH identified five case scenarios that describe the incidents resulting in 244 fatalities:

(1) direct worker contact with an energized powerline (28%);

(2) direct worker contact with energized equipment (21%);

(3) boomed vehicle contact with an energized powerline (18%);

(4) improperly installed or damaged equipment (17%);

(5) conductive equipment contact with an energized powerline (16%).

Scenario 1

Workers in various occupations such as sign technicians, tree trimmers, utility line workers, and telecommunication workers are often exposed to overhead powerlines. These exposures can be greatly reduced by isolating or insulating the energy source from the worker. This can be accomplished by erecting a physical barrier, by insulating the powerline, or by following required clearance distances. More than once during NIOSH fatality investigations, co-workers interviewed did not know the powerlines posed a hazard, i.e., they thought the powerlines were insulated.

Scenario 2

Direct worker contact with energized equipment can occur in a variety of ways. Maintenance technicians might inadvertently contact overhead crane runway conductors. Electricians or technicians troubleshooting or testing electric circuitry might contact an energized circuit. Maintenance workers may fail to replace an isolating plate covering electrical conductors, exposing passing workers. Compliance with the applicable articles of the National Electrical Code and lockout/tagout procedures established by OSHA could eliminate the potential for such contact, thereby reducing the risk of electrocution.

Scenario 3

Workers guiding suspended loads, or standing against or near a crane or other boomed vehicle—such as a concrete pumping truck, or derrick truck—whose boom contacts a powerline are in danger of electrocution. The risk of electrocution could be reduced if OSHA regulations regarding clearance distances [(29 CFR 1926.550 (a)(15)] are observed, or if the required lookout person [29 CFR 1926.550 (a)(15)(iv)] is utilized.

Scenario 4

Improperly installed or damaged equipment can be responsible for occupational electrocutions in a variety of ways. The most frequently cited OSHA electrical regulation is improper grounding of equipment or electrical circuitry. If the frame of a piece of electrical equipment or machinery does not have a grounding conductor attaching the frame to ground, as required to divert dangerous fault current to ground, and an electrical fault occurs, anyone touching that frame and any other object at ground potential would receive an electrical shock. Should a fault occur with a grounding conductor present, the circuit would open or trip as an alert that a problem existed, except in high-resistance grounding applications. Damaged guards can expose workers to energized conductors in proximity to their work areas. Additionally, damaged extension cords or extension cords with their ground prong removed can expose workers to the danger of electrocution. Failure to maintain a continuous path to ground can expose entire electrical systems to damage and can expose the structures within which they are housed and workers within these structures to electrical and fire hazards.

For example, many electrical systems are installed in a manner that allows a structure's water pipes or other conductive conduit to serve as a continuous path to ground in compliance with the

NEC. However, NIOSH fatality investigations have identified cases of electrocution or fire as a result of an interruption in a continuous path to ground. During renovation or repair activities, conductive components may be replaced by nonconductive components such as PVC pipe, which will interrupt the path to ground.

This may result in fire due to the intense overheating of components of the electrical system. Additionally, workers contacting improperly grounded components while being at ground potential would be exposed to electric shock.

Scenario 5

The task of positioning or repositioning conductive equipment may place more than one worker at risk. The weight of mobile scaffolding, grain augers, or aluminum extension ladders equipped with pendant-operated lifts often requires more than one worker for positioning or repositioning, resulting in multiple electrocutions if contact with an overhead powerline occurs. Using a lookout person, observing required clearance distances, or lowering this equipment before transport would greatly reduce worker exposure to any potential electrical hazards present.

Fatality data help to illustrate the magnitude of the electrocution problem nationally and allow a comparison of the potential risks in various industries. The information from NIOSH investigations allows for the identification of more detailed information on electrocution hazards, such as contact with overhead powerlines, contact with exposed conductors, inadequate personal protective equipment, and nonexistent lockout/tagout procedures, or other measures necessary for working around energized conductors and equipment.

Fatality reports and death certificates identified many of the same hazards for fatal electrocutions.

The largest number of deaths were in Construction, Transportation/Communication/Public Utilities, and Manufacturing, while the highest fatality rates were in the Construction and Mining industries.

Linemen were involved in the largest number of electrocutions.

Direct worker contact with an energized powerline caused the largest number of electrocution deaths.

Almost all of the incidents investigated by NIOSH involved alternating current. More than half of these incidents involved voltages of more than 600 volts. Of the 147 higher-voltage electrocutions, over two-thirds involved distribution voltages (7,200-13,800 volts).

While progress has been made in reducing the number of work-related electrocutions, (50% decrease from 1980-1992), additional efforts are needed if we are to continue progress towards preventing deaths due to electrocution, according to NIOSH.

It's clear the positive and life-saving role training can play in preventing these tragedies.

Tesla's solar panels reportedly caught fire at an Amazon warehouse (updated)

The e-commerce giant reportedly experienced the same thing Walmart did.

Mariella Moon, @mariella_moon

08.24.19 in Green

Andrei Stanescu via Getty Images

Walmart recently filed a lawsuit against Tesla after its solar panel installations on seven of the retail giant's stores caught fire. The retail corporation accused Elon Musk's company of poor safety practices, such as not grounding electrical systems properly and sending inspectors who "lacked basic solar training and knowledge." Now, Amazon, another massive corporation, has stepped forward to claim that the solar panels installed by Tesla's SolarCity division burst into flames, as well. According to *Bloomberg*, Tesla's solar panels caught fire on the roof of one of Amazon's warehouses in Redlands, California.

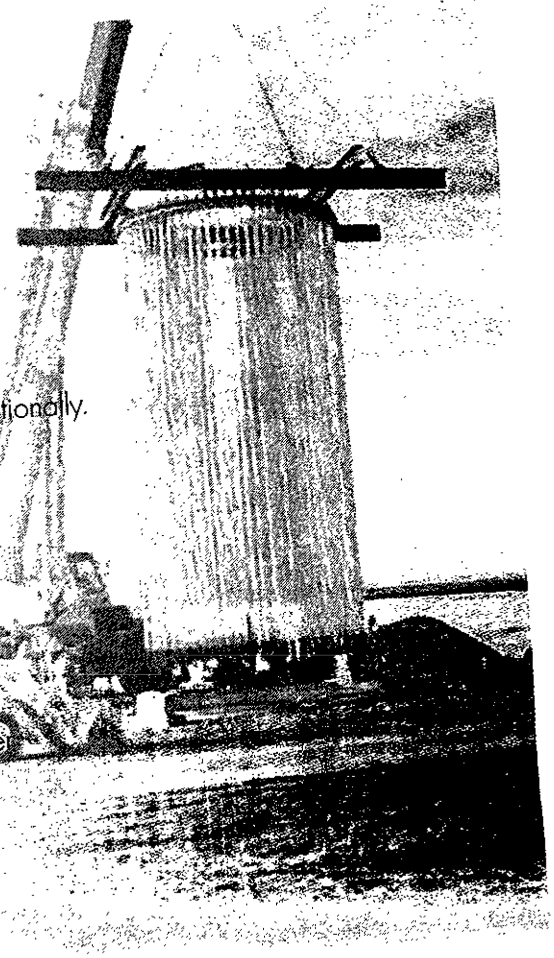
The incident reportedly happened back in June 2018, but the e-commerce giant just came out with the information. *Bloomberg* says Amazon told the publication via email that it has taken steps to protect its facilities and will no longer install any more Tesla systems going forward. We've reached out to both companies to confirm the news and will let you know if they do, and if they're planning to work things out.

After news came out that Walmart sued Tesla, the companies released a statement saying they're in discussion to resolve the issue. The Amazon warehouse incident seems to be much smaller in scale -- the e-commerce giant said it has a very small number of Tesla solar installations to begin with -- but a claim from such an enormous company still isn't a good look for SolarCity. The division's operations haven't been going as well as the company had hoped. It reportedly faced production issues last year due to technical challenges, and a more recent report said it's been exporting the majority of the solar cells produced at its New York gigafactory instead of using them for Solar Roof installations.

Update: 08/26 6:40am ET: Tesla shared this statement with us.

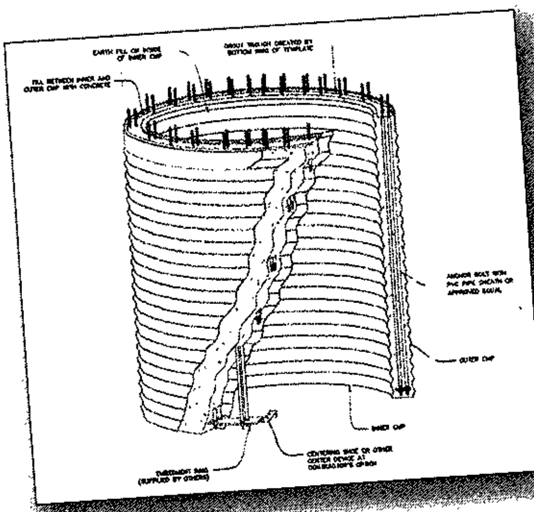
"All 11 Amazon sites with solar from Tesla are generating energy and are proactively monitored and maintained. Last year, there was an isolated event that occurred in an inverter at one of the Amazon sites. Tesla worked collaboratively with Amazon to root cause the event and remediate. We also performed inspections at the other sites, which confirmed the integrity of the systems. As with all of our commercial solar installations, we continue to proactively monitor the systems to ensure they operate safely and reliably."

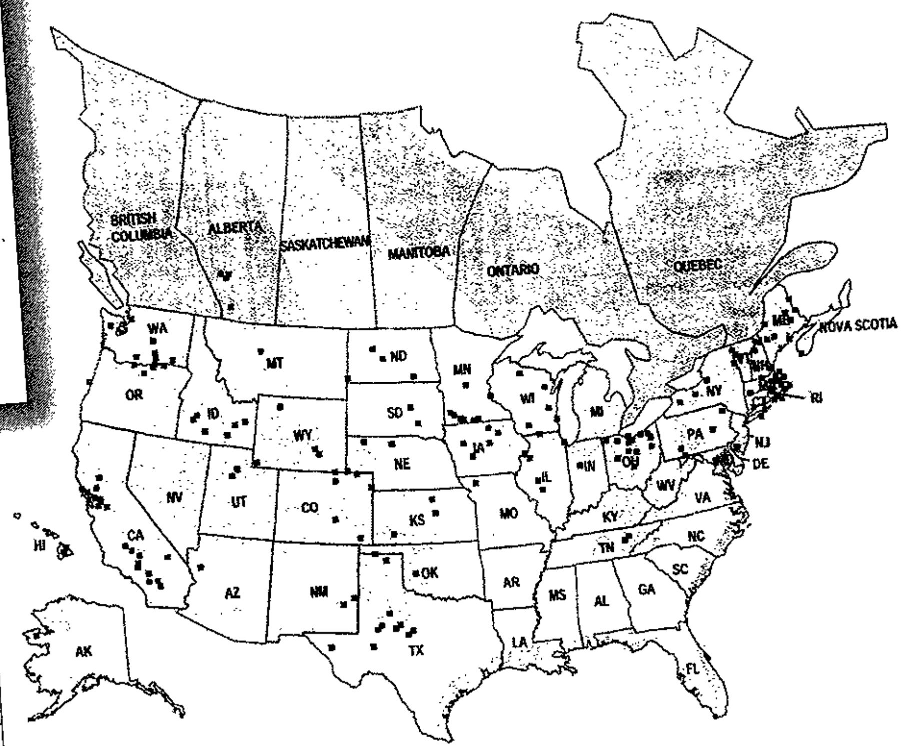
TENSIONLESS PIER FOUNDATION



Advantages

- Turbine sizes: 100 KW to 3 MW installed, with capacity for larger. Supports the largest turbines to date both in North America and internationally.
- Most efficient, **cost-effective** foundation solution – more than 6,000 installations
  - Typical and historical foundation savings in excess of 25% as compared to shallow foundations in various soil conditions
  - Most efficient utilization of time and resources
  - 3-6% reduction in total project development costs
- Well suited for varying soil conditions (See table A, page 2)
- Deep foundations are superior for seismically active zones, floodwater inundation, flood scour, frost depth, creeps and landslides
- Extended fatigue life characteristics due to post tensioning





MAP KEY	
PLOTS	
Red	= Tensionless Pier
Blue	= Rock Anchor
Black	= Soil Anchor
SHADES	
Green	= Good conditions
Blue	= Need further investigation
Red	= Not recommended

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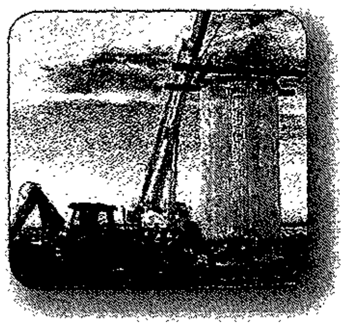

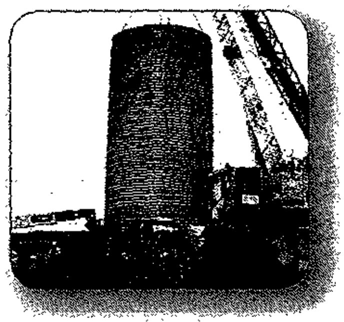

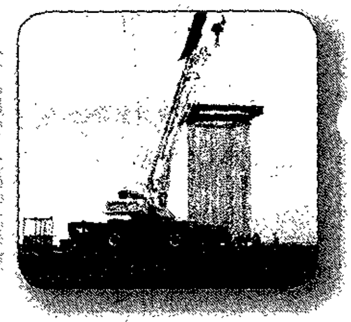

Site Conditions						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Valley/Plains	B	Not Recommended	B	A	A	B
Hills	A	C	A	B	B	B
Mesa	A	A	D	Not Recommended	Not Recommended	B
Mountain	A	A	Not Recommended	Not Recommended	Not Recommended	C
Ground Conditions						
Hard Rock	A	A	Not Recommended	Not Recommended	Not Recommended	C
Soft Rock	A	A-	C	Not Recommended	D	B
Very Dense/Hard Soil	A	Not Recommended	A	D	C	B+
Soil with Boulders and Cobbles	A-	Not Recommended	Not Recommended	Not Recommended	Not Recommended	B
Soil Dry to Moist	A-	Not Recommended	A-	D	A	B
Silty Soil Dry to Moist	B+	Not Recommended	B+	B	A-	B-
Clay Soil Day to Moist	A-	Not Recommended	C	D-	C	B
Granular Soil Shallow Ground Water	D	Not Recommended	D	B	B+	C+
Silty Soil Wet	D	Not Recommended	D	D	B	C+
Clay Soil Wet	C+	Not Recommended	D	D	B	B
Organic Soil	D	Not Recommended	C	B	B	C+
Combined Ground Conditions						
Soil Over Shallow Rock	A	A	Not Recommended	Not Recommended	Not Recommended	B
Soil Over Deep Rock	B+	C	D	Not Recommended	Not Recommended	B
Intermittent Soil and Rock	B+	A-	Not Recommended	Not Recommended	Not Recommended	B+
Landfill Over Rock	Not Recommended	A*	Not Recommended	Not Recommended	Not Recommended	D
Landfill Over Soil	Not Recommended	Not Recommended	Not Recommended	Not Recommended	A*	D
Mine Spoil	B	D	Not Recommended	Not Recommended	Not Recommended	C
Hazardous Conditions						
Seismic	A	A	A	A	A	D
Liquefaction	A	n/a	Not Recommended	A	A	Not Recommended
Flood Water Inundation	A	A	A	A	A	C
Flood Scour and Erosion	A	A	A	A	A	D
Storm Surge	A	A	A	A	A	D
Frost Depth	A	A	B+	B+	B+	C
Creeps and Landslide	C	D	D	C	C	Not Recommended
Water Sensitive Collopsible Soil (Loess)	A	Not Recommended	A	C	A	D
Remediation						
Stability/Tilt Pressure Grouting	B	B	B	B	B	C
Structural Concrete Addition Stability/Tilt	B	C	B	B	B	D
Anchor Addition Stability/Tilt	C	A	A	A	A	C
Corrosive Conditions	B	B	B	B	B	B
Longevity						
Fatigue Failure	A	B+	B	B	B	D
Post Tensioned by Horizontal Reinforcing	n/a	A	A	A	A	C

* Coupled with Compression Pipe Pile

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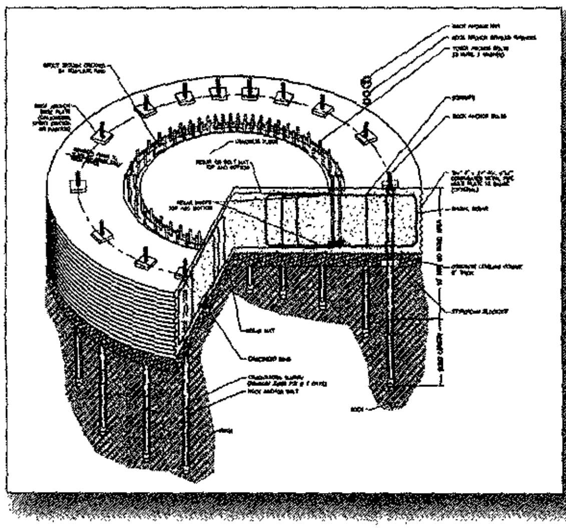
ANCHOR DEEP FOUNDATIONS

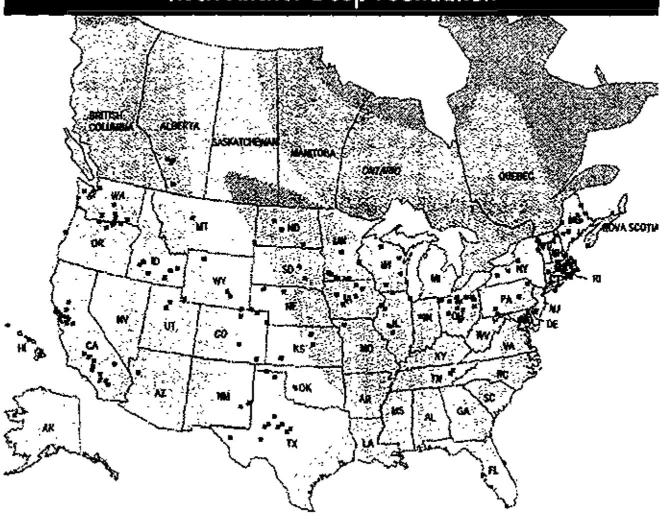
Advantages

- Ability to support the largest available turbine systems
- Anchor foundation systems excel in every soil type (See table A, page 2)
- Reduced footprint and site disturbance
- Reduction and potential elimination of blasting requirements
- Increased stiffness and long-term reliability
- Maximizes material and resource efficiencies
- Superior for mountain and remote access sites

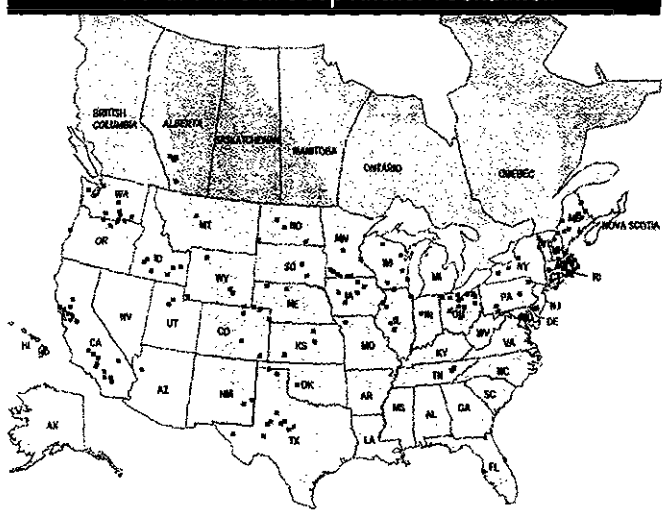


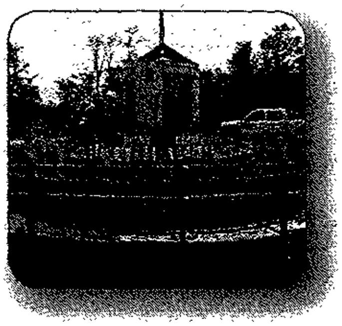
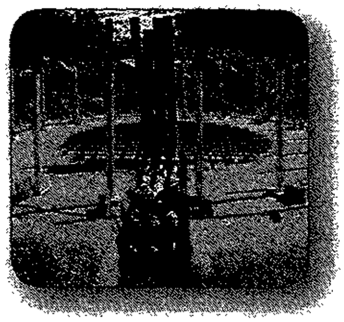
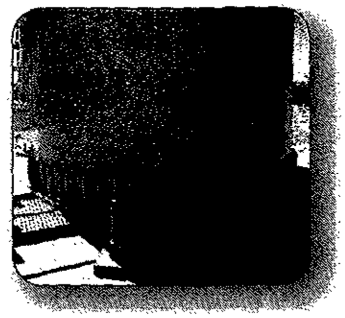
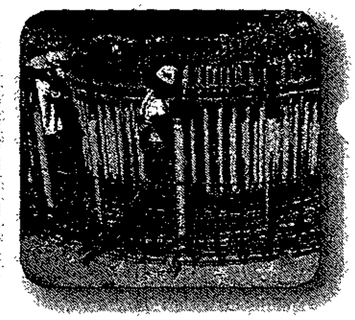
MAPS KEY			
PLOTS		**SHADES**	
Red	= Tensionless Pier	Green	= Good conditions
Blue	= Rock Anchor	Blue	= Need further investigation
Black	= Soil Anchor	Red	= Not recommended

Rock Anchor Deep Foundation



Helical and Soil Deep Anchor Foundation



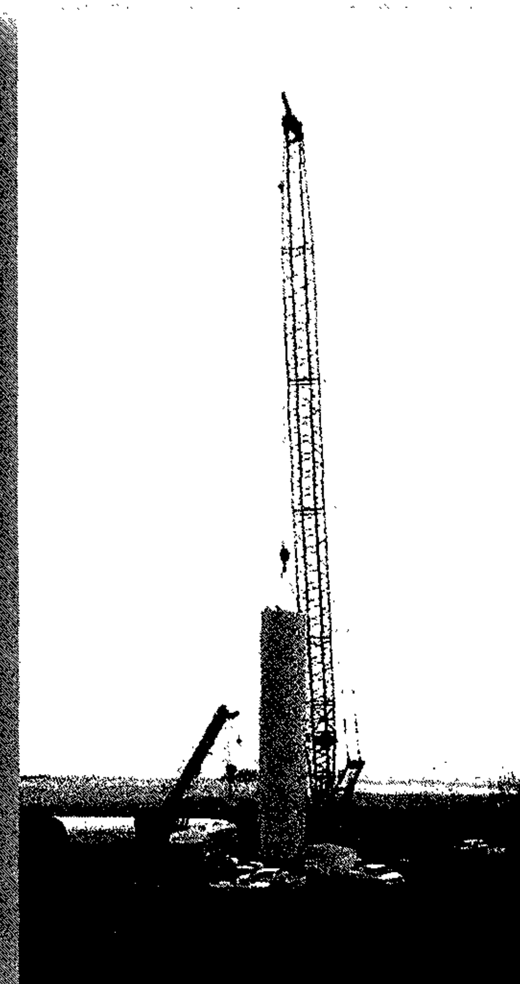





Site Conditions						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Valley/Plains	B	Not Recommended	B	A	A	B
Hills	A	C	A	B	B	B
Mesa	A	A	D	Not Recommended	Not Recommended	B
Mountain	A	A	Not Recommended	Not Recommended	Not Recommended	C
Ground Conditions						
Hard Rock	A	A	Not Recommended	Not Recommended	Not Recommended	C
Soft Rock	A	A-	C	Not Recommended	D	B
Very Dense/Hard Soil	A	Not Recommended	A	D	C	B+
Soil with Boulders and Cobbles	A-	Not Recommended	Not Recommended	Not Recommended	Not Recommended	B
Soil Dry to Moist	A-	Not Recommended	A-	D	A	B
Silty Soil Dry to Moist	B+	Not Recommended	B+	B	A-	B-
Clay Soil Dry to Moist	A-	Not Recommended	C	D-	C	B
Granular Soil Shallow Ground Water	D	Not Recommended	Not Recommended	A	A	C+
Silty Soil Wet	D	Not Recommended	D	D	B	C+
Clay Soil Wet	C+	Not Recommended	D	D	B	B
Organic Soil	D	Not Recommended	C	B	B	C+
Combined Ground Conditions						
Soil Over Shallow Rock	A	A	Not Recommended	Not Recommended	Not Recommended	B
Soil Over Deep Rock	B+	C	D	Not Recommended	Not Recommended	B
Intermittent Soil and Rock	B+	A-	Not Recommended	Not Recommended	Not Recommended	B+
Landfill Over Rock	Not Recommended	A*	Not Recommended	Not Recommended	Not Recommended	D
Landfill Over Soil	Not Recommended	Not Recommended	Not Recommended	Not Recommended	A*	D
Mine Spoil	B	D	Not Recommended	Not Recommended	Not Recommended	C
Hazardous Conditions						
Seismic	A	A	A	A	A	D
Liquefaction	A	n/a	Not Recommended	A	A	Not Recommended
Flood Water Inundation	A	A	A	A	A	C
Flood Scour and Erosion	A	A	A	A	A	D
Storm Surge	A	A	A	A	A	D
Frost Depth	A	A	B+	B+	B+	C
Creeps and Landslide	C	D	D	C	C	Not Recommended
Water Sensitive Collapsible Soil (Loess)	A	Not Recommended	A	C	A	D
Remediation						
Stability/Tilt Pressure Grouting	B	B	B	B	B	C
Structural Concrete Addition Stability/Tilt	B	C	B	B	B	D
Anchor Addition Stability/Tilt	C	A	A	A	A	C
Corrosive Conditions	B	B	B	B	B	B
Longevity						
Fatigue Failure	A	B+	B	B	B	D
Post Tensioned by Horizontal Reinforcing	n/a	A	A	A	A	C

* Coupled with Compression Pipe Pile

FOUNDATIONS FOR WIND TURBINES

ENGR 340 – Fall 2011



Jeramy C. Ashlock
Assistant Professor, CCEE

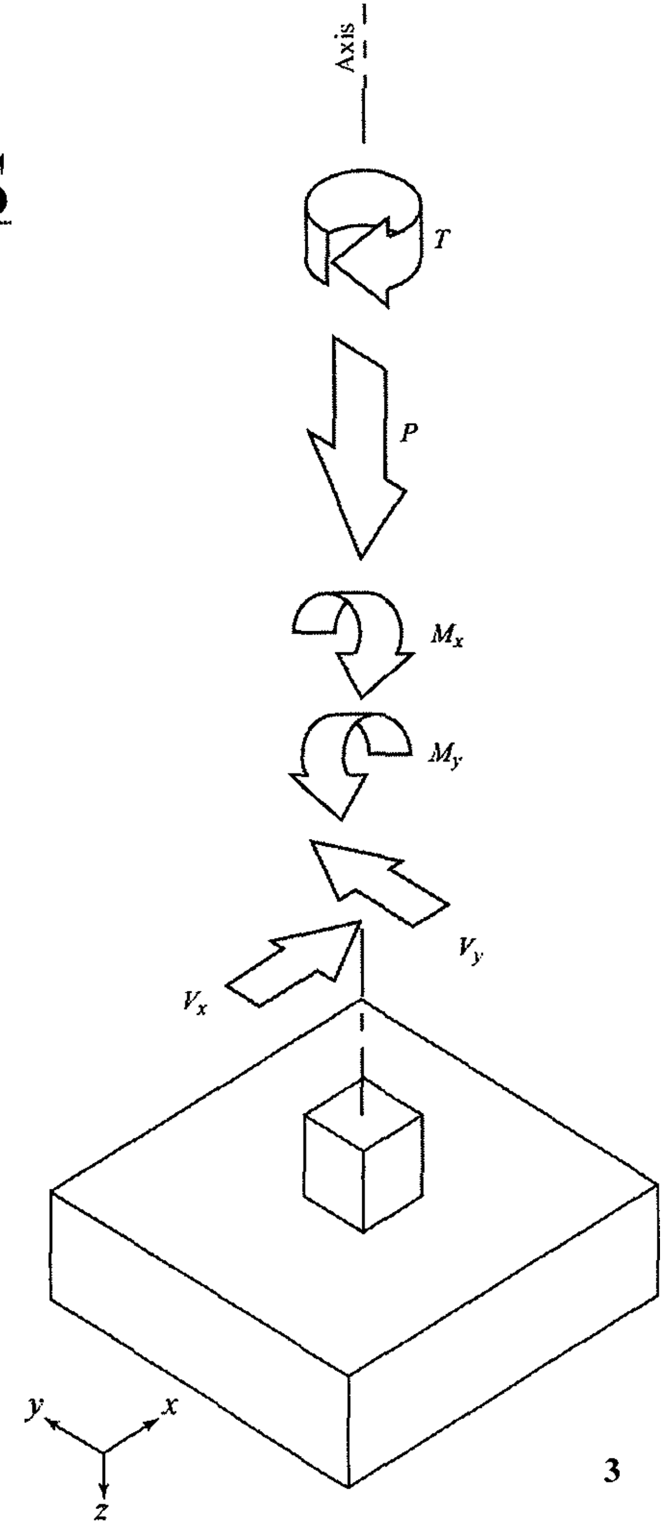
Vern Schaefer
Professor, CCEE

OUTLINE

Topics	Lecture #
Design requirements, Foundation types	1
Overview of geotechnical engineering • Soil mechanics • Site investigations • In-situ tests • Laboratory tests	1 & 2
Foundations for wind turbines, Design example	2

TURBINE FOUNDATION LOADS

- Vertical, shear forces and significant overturning moments are transmitted to foundation by tower
- Must be resisted within tolerances for foundation settlement and tilt
- Manufacturers typically specify horizontal and rotational foundation stiffness criteria
- Loading direction changes with wind direction and nacelle orientation
- Circular foundation shape is therefore optimal, but straight-sided (e.g. octagonal, hexagonal) is easier to construct
- Anchors can be used to add rotational strength



FOUNDATION CONTACT STRESS UNDER ECCENTRIC/MOMENT LOADS

To prevent loss of contact and uplift, the foundation is typically designed such that the eccentricity e of the resultant is $e < B/6$. In other words, $M<PB/6$.

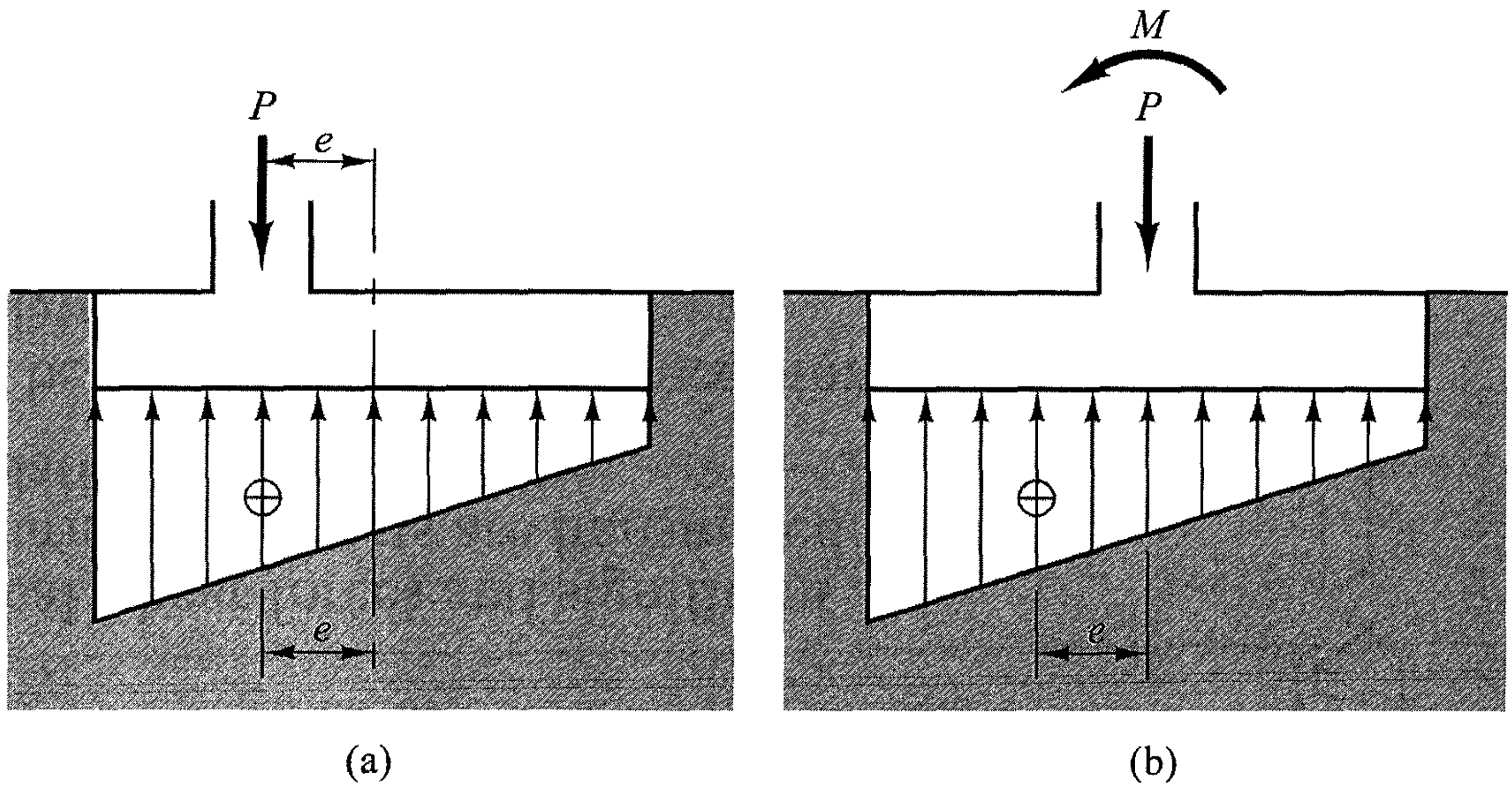
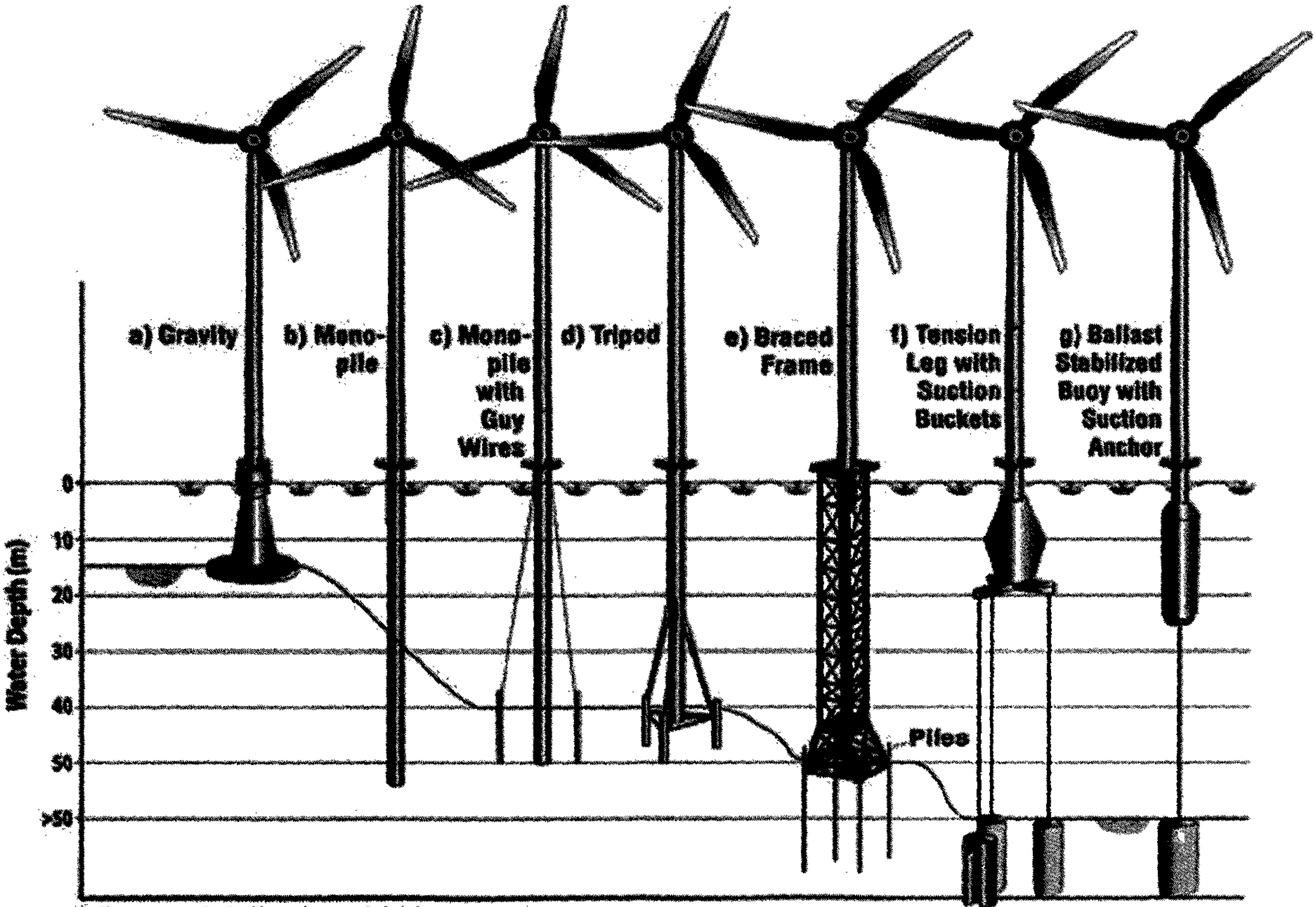


Figure 5.14 (a) Eccentric and (b) moment loads on shallow foundations.

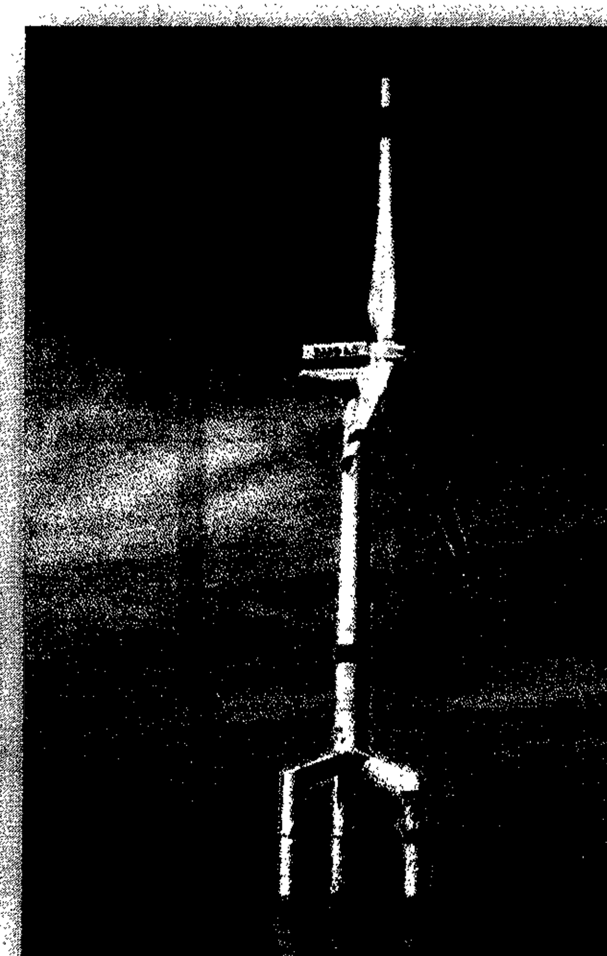
OFFSHORE FOUNDATION OPTIONS



Source: Malhothra, 2011

OFFSHORE FOUNDATIONS

Photos: NREL



TYPICAL TURBINE FOUNDATION OPTIONS

- On rock or competent soil:
  - Shallow concrete “inverted tee” mat foundations ($)
- On weak or soft soils (bearing capacity or stiffness too low, settlements too high):
  - Rammed Aggregate Piers or VibroPiers under footings or mats ($$)
  - Soil improvement such as deep soil mixing, compaction, over-excavation & replacement with compacted lifts of aggregate ($$$)
  - Deep foundations; piles, drilled shafts ($$$$)
  - Concrete-filled corrugated pipe with post-tensioned anchor bolts (proprietary design; $$?)

SHALLOW/SLAB FOUNDATION VARIANTS

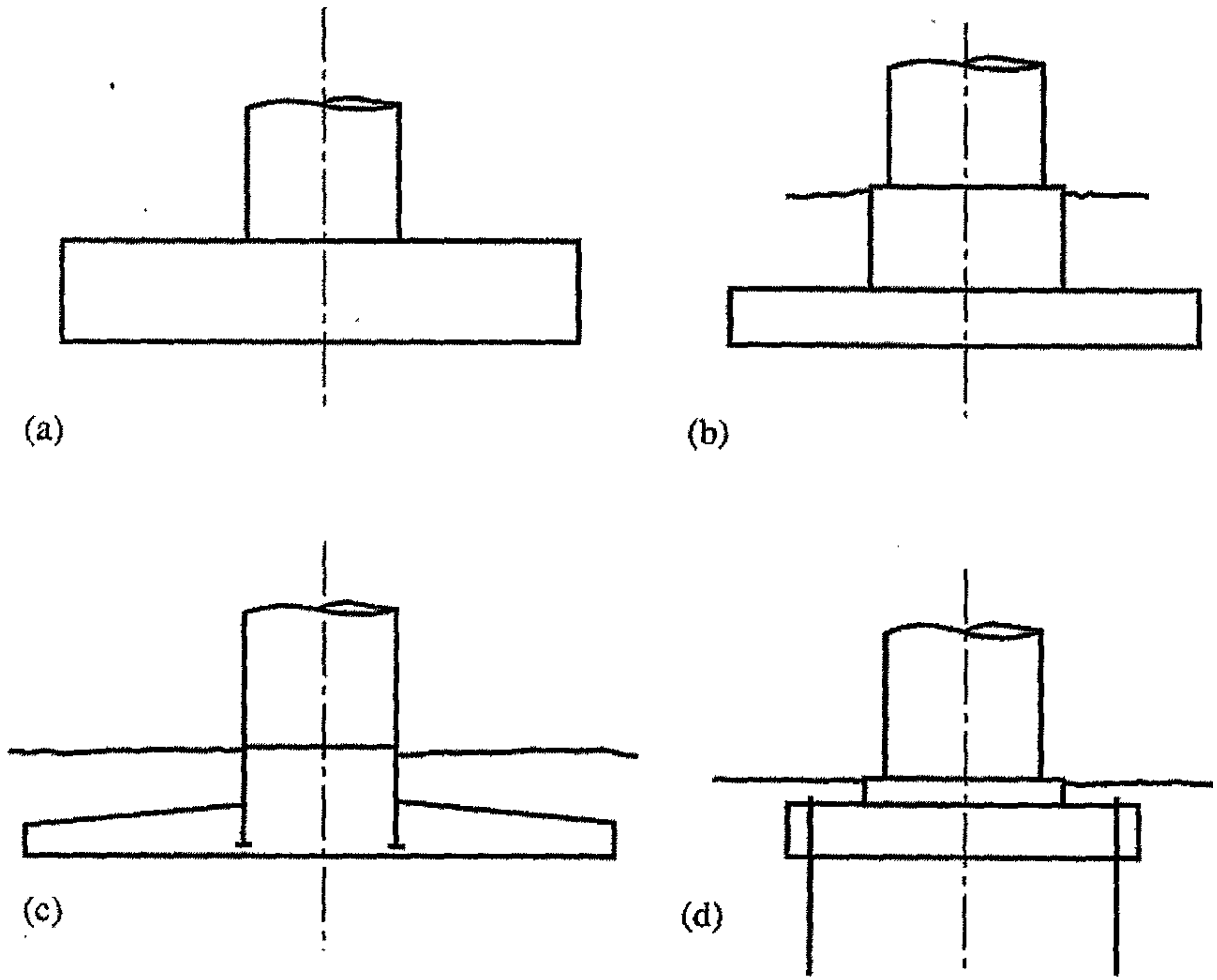


Figure 7.44 (a) Plain Slab; (b) Stub and Pedestal; (c) Stub Tower Embedded in Tapered Slab; (d) Slab Held Down by Rock Anchors

PILED FOUNDATION VARIANTS

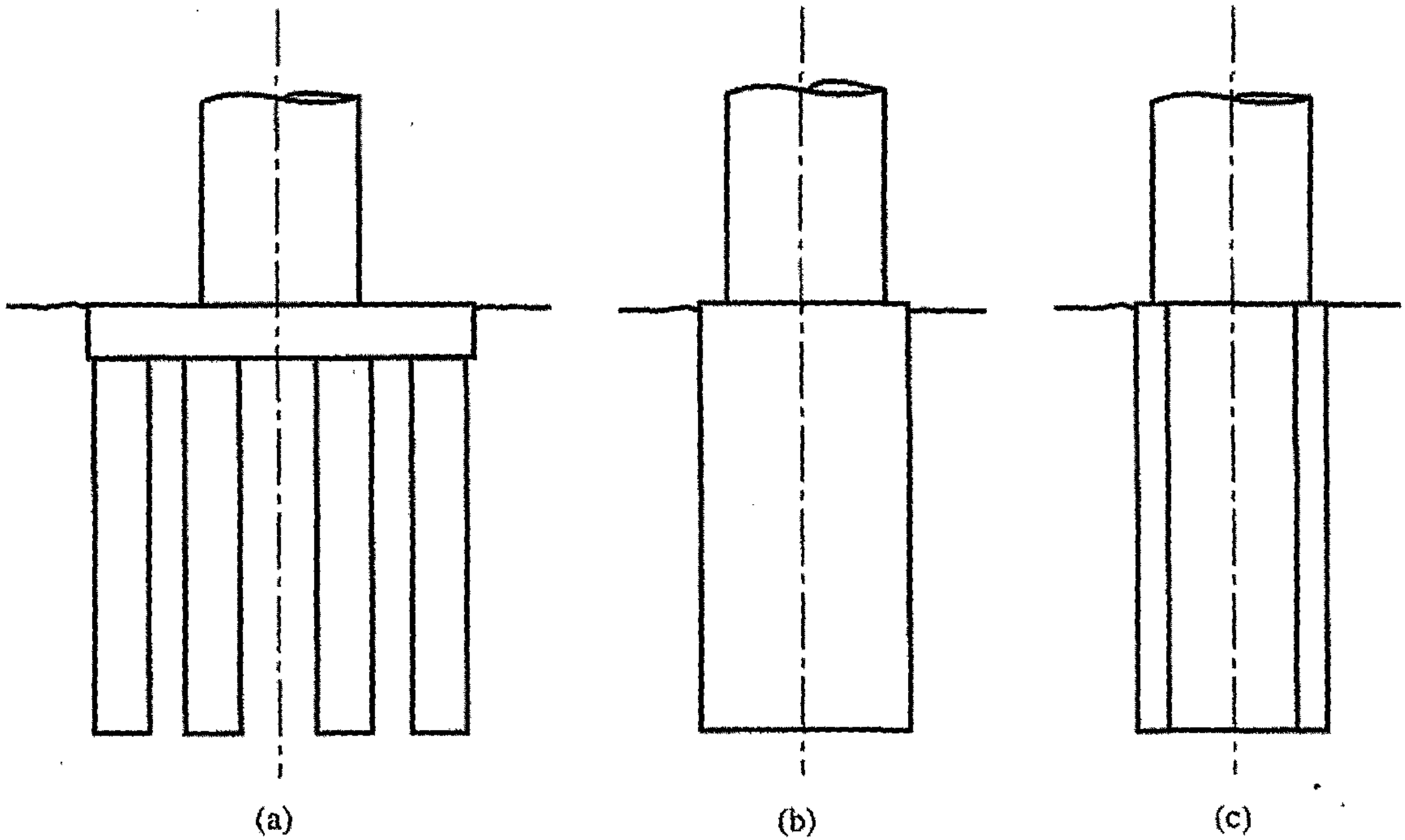
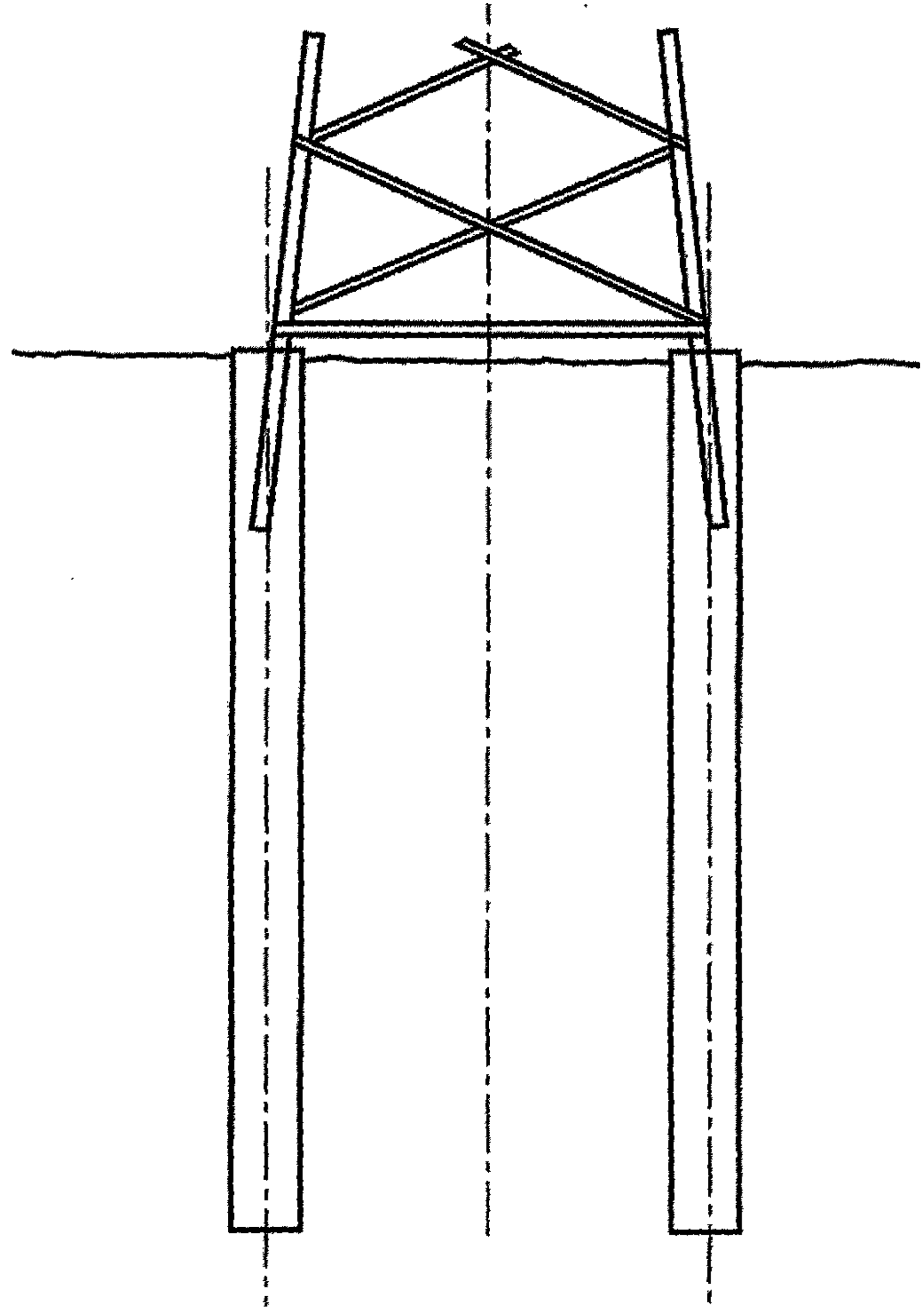


Figure 7.45 (a) Pile Group and Cap; (b) Solid Mono-pile; (c) Hollow Mono-pile

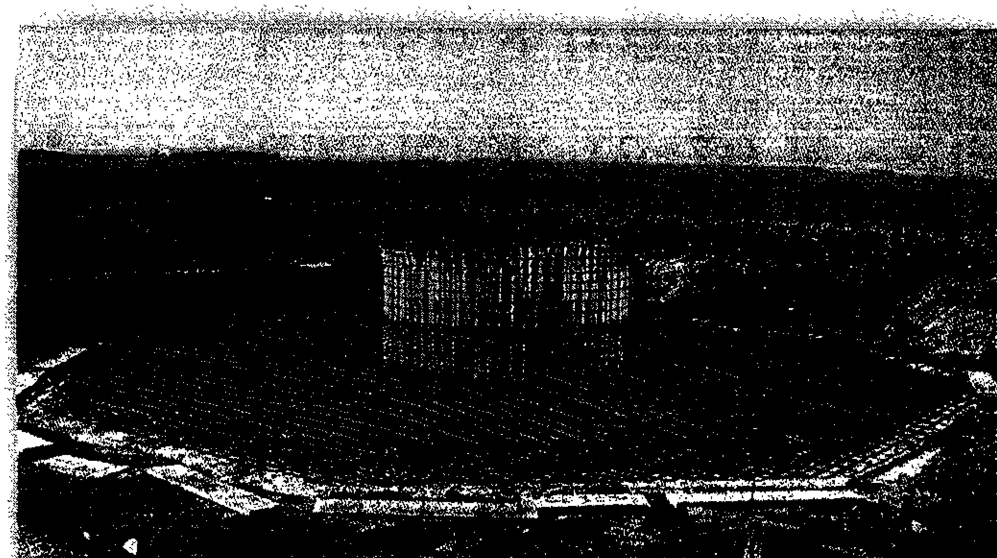
PILED FOUNDATION VARIANTS

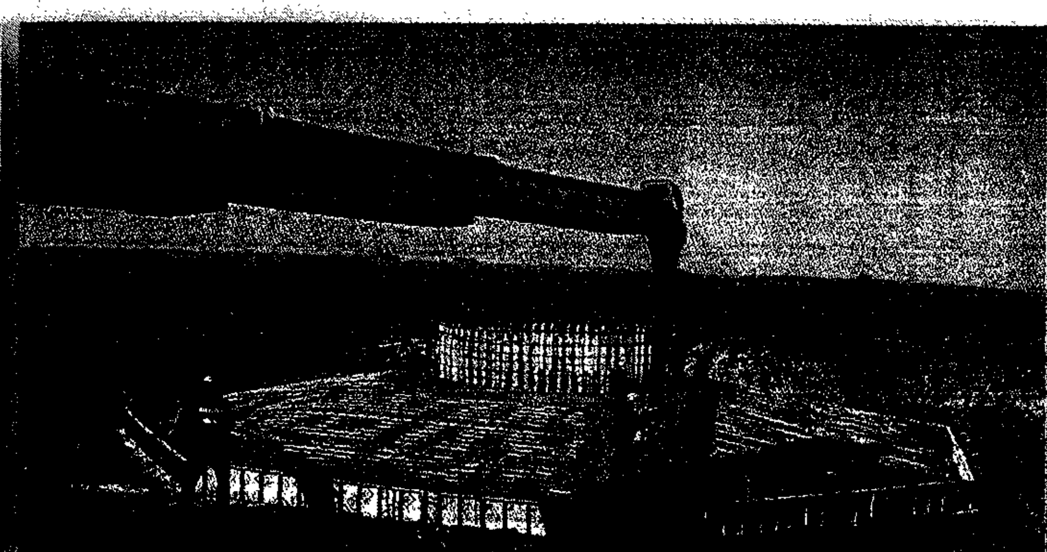


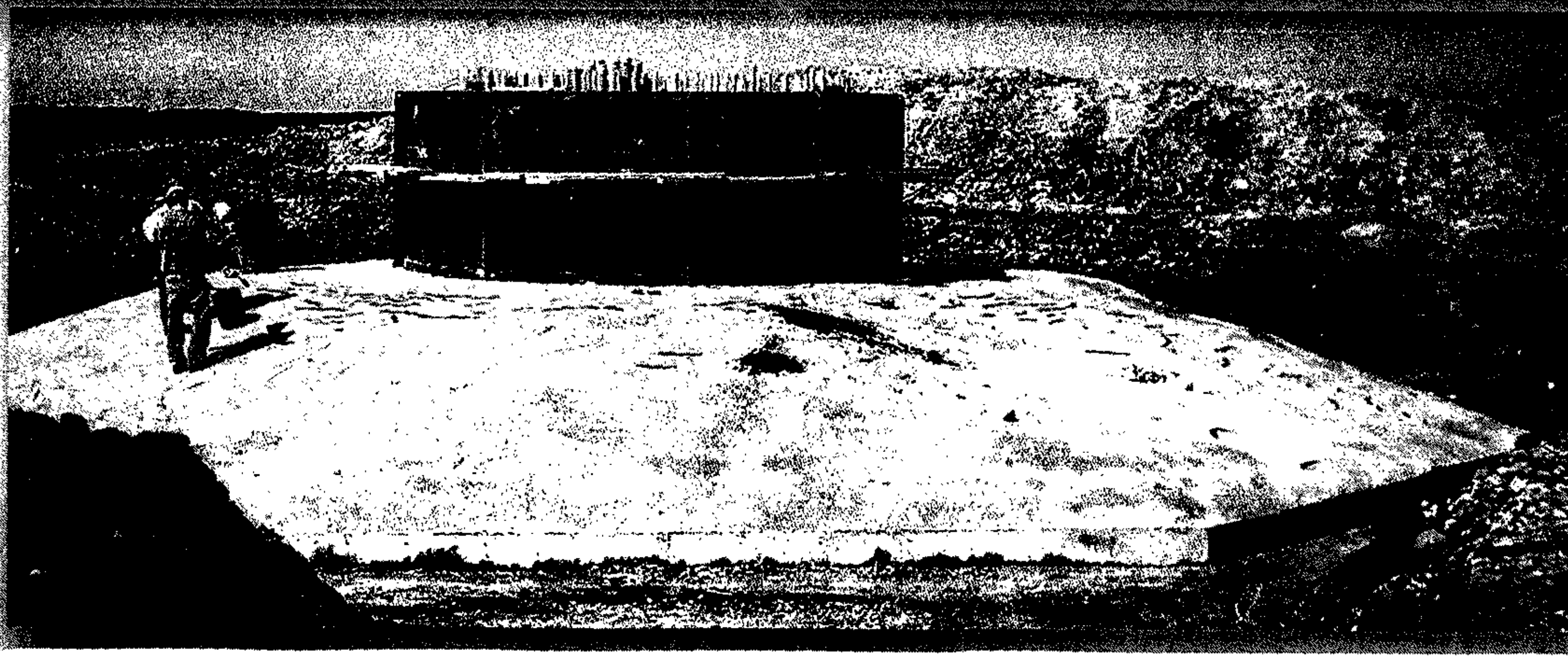
Figur .46 Piled Foundation for Steel Latt Tower[10]

OCTAGONAL SHALLOW MAT FOUNDATIONS

Source: GeoPier / http://www.windsystemsmag.com/view/article.php?articleID=97



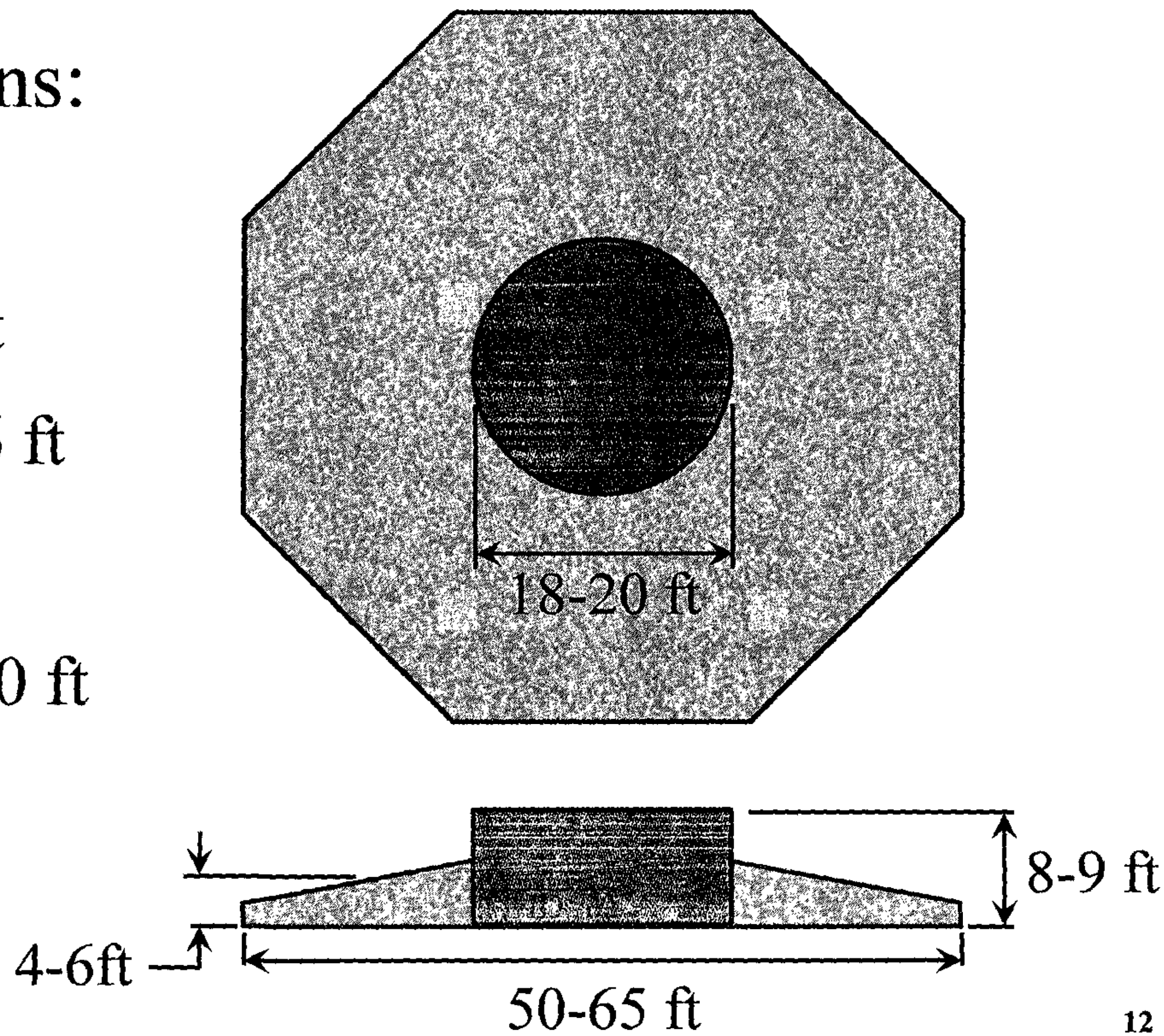




OCTAGONAL SHALLOW MAT FOUNDATIONS

Typical dimensions:

- Footing
  - width: 50-65 ft
  - avg. depth: 4-6 ft
- Pedestal
  - diameter: 18-20 ft
  - height: 8-9 ft



RAMMED AGGREGATE PIERS (RAPs) UNDER FOOTINGS OR MATS

Source: GeoPier / http://www.windsystemsmag.com/view/article.php?articleID=97

INNOVATIVE TURBINE FOUNDATION SOLUTIONS

The Rammed Aggregate Pier system designed by the Geopier Foundation Company, provides reliable support solutions for tower foundations.

By Brendan FitzPatrick, P.E.

RAPs UNDER FOOTINGS OR MATS

RAPs are used for

- Decreased settlements
- Improved bearing capacity in weak or compressible soils
- Increased rotational stiffness
- Uplift resistance

Alternative solutions for uplift resistance:

helical anchors or helical piles

ANCHORS FOR UPLIFT RESISTANCE

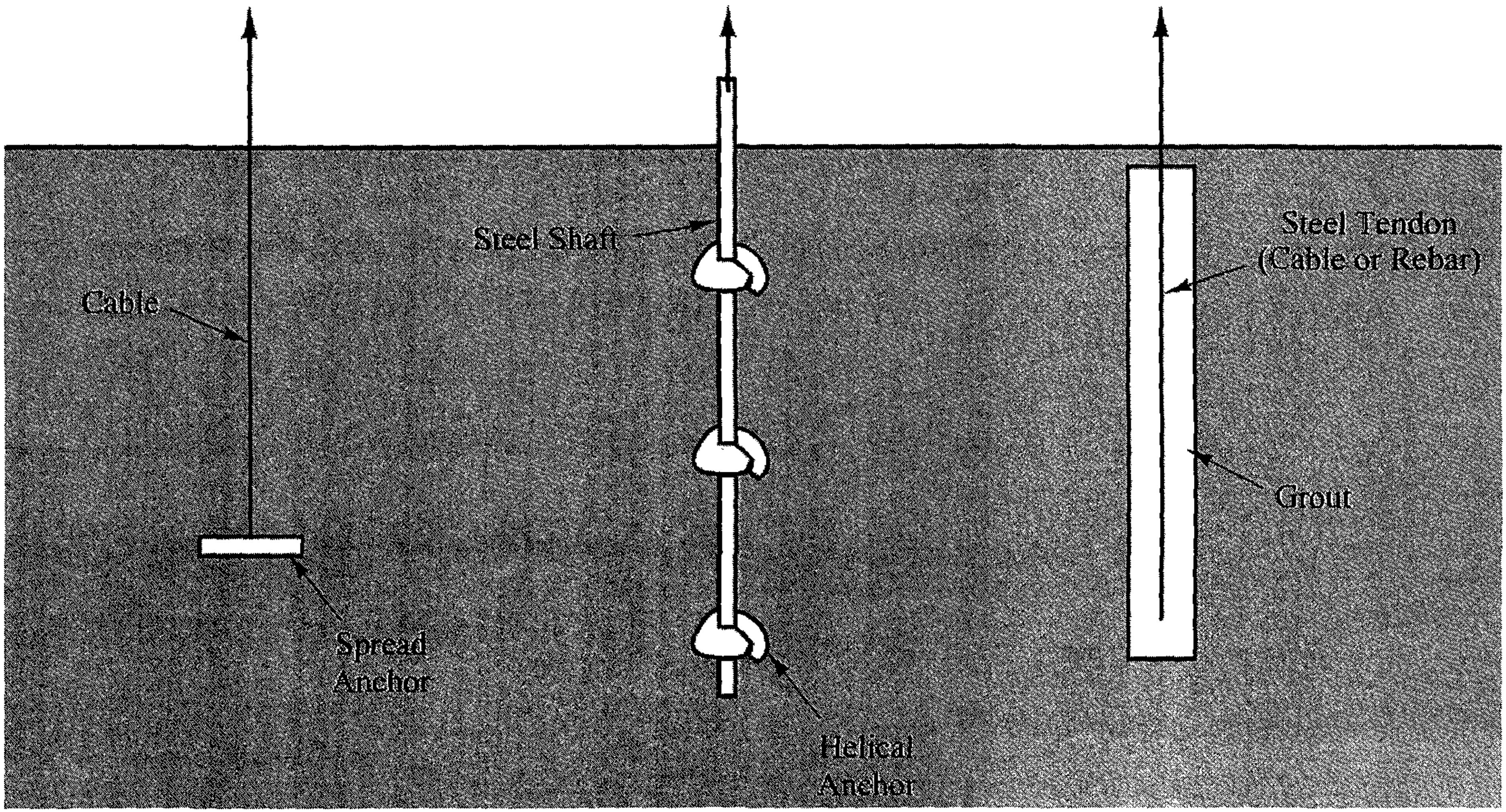
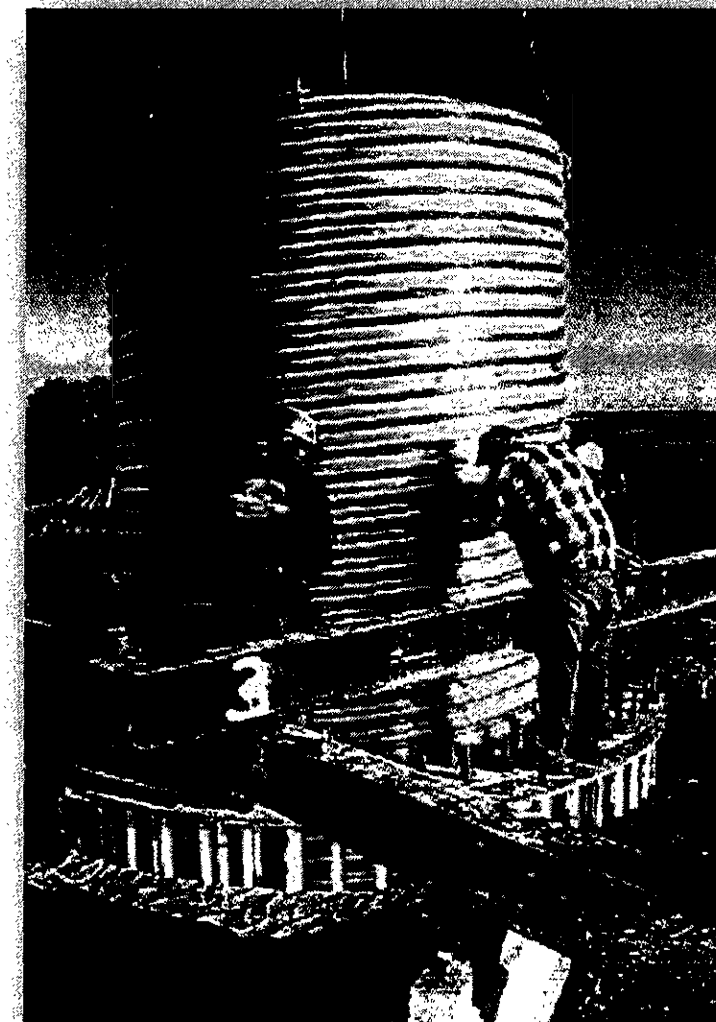


Figure 11.51 Types of anchors (Adapted from Kulhawy, 1985; Used with permission of ASCE).

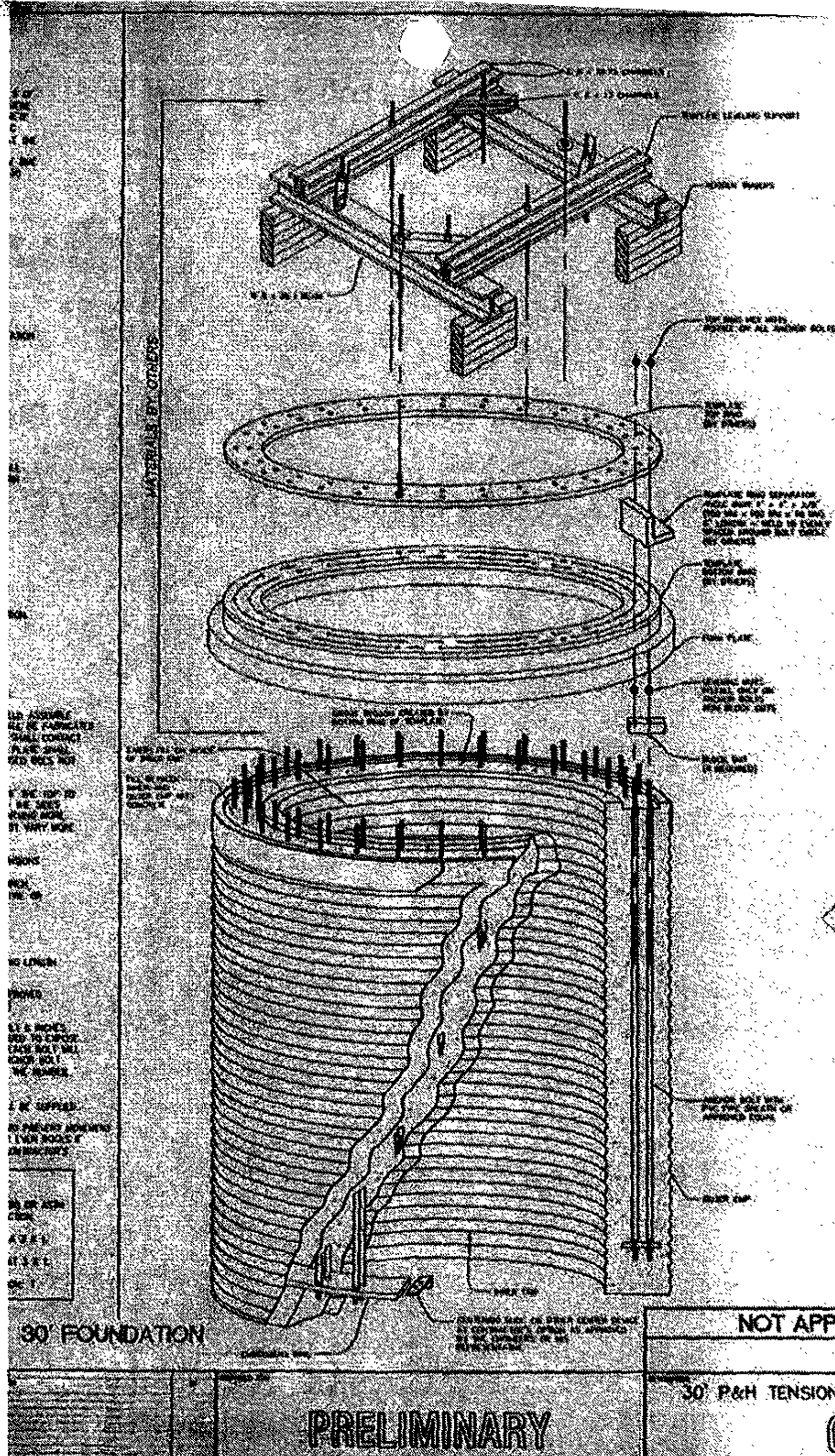
P&H TENSIONLESS FOUNDATION DESIGN

- Proprietary design of Patrick & Henderson, Inc.
  - concentric corrugated metal pipes filled with concrete that is compressed by post-tensioned rods



http://www.maine.gov/doc/lurc/projects/redington/Click_to_Start.htm

For more info, see
Patent # 5586417
patents.google.com



CONSTRUCTION SEQUENCE:

1. EXCAVATE FOUNDATION HOLE BY TRACK EXCAVATOR OR DRILL RIG. EX[illegible] HOLE MUST BE A MINIMUM OF 12" LARGER IN DIAMETER THAN THE OUTER CMP DIAMETER. [illegible] HOLE SHALL BE COVERED OR CIRCLED BY FENCING TO PREVENT UNAUTHORIZED ENTRANCE.
2. PLACE, PLUMB, AND SECURE OUTER CMP INTO FOUNDATION EXCAVATION.
3. A) PLACE GROUNDING WIRE OUTSIDE CMP AS REQUIRED.
   B) SLURRY ANNULAR SPACE BETWEEN FOUNDATION EXCAVATION HOLE AND EXTERIOR OUTER CMP.
   C) CUT HOLES FOR CONDUITS AND PLACE CONDUIT AS REQUIRED TO CONFORM TO CONSTRUCTION METHODOLOGY EMPLOYED BY THE CONTRACTOR.
4. SET TOP FORM PLATE.
5. POSITION BOTTOM EMBEDMENT RING INSIDE OUTER CMP.
6. LOWER AND STAND A PACKAGED GROUP OF ANCHOR BOLTS IN EACH QUADRANT INSIDE THE OUTER CMP.
7. LOAD TEMPLATE AND EMBEDMENT RING WITH BOLTS. SECURE WITH NUTS, CENTER BOLTS AND RING. LIFT TEMPLATE, PLACE AND TIE REBAR WRAP. TIE FOUR (4) REBAR HOOP WRAPS AROUND EACH OUTER ANCHOR BOLT AT EQUALLY SPACED VERTICAL INTERVALS AS SHOWN ON SHEET S-3 AT MAXIMUM [illegible] SPACING.
8. PLACE, PLUMB, AND SECURE BOLT/TEMPLATE ASSEMBLY INSIDE OUTER CMP.
9. PLACE, PLUMB AND SECURE INNER CMP INSIDE EMBEDMENT AND TEMPLATE RINGS. BACKFILL WITH EXCAVATED MATERIAL EXCLUDING ROCK IN EXCESS OF 2 FEET (0.6 M) IN DIAMETER TO WITHIN 4 TO 5 FEET (1.2 TO 1.5 M) FROM TOP OF INNER CMP.
10. INSTALL ELECTRIC AND COMMUNICATION CONDUITS THROUGH CMP'S. PLACE GROUNDING WIRE FOR INNER CMP.
11. CONTINUE BACKFILL OF INNER CMP TO FLOOR DEPTH. PLACE NO. 4 REBAR OR WIRE MESH FOR CONCRETE FLOOR REINFORCEMENT. INSTALL STYROFOAM BLOCKOUTS. INSTALL 4" [illegible] PVC DRAIN PIPE FOR CENTRAL DRAIN.
12. CHECK LEVEL ON TEMPLATE. PLACE [illegible], AND PUMP CONCRETE. CONCRETE FLOOR TO BE POURED MONOLITHICALLY. FLOOR TO SLOPE A MINIMUM OF 1 INCH (25 MM) FROM SIDES TO CENTER DRAIN PIPE. FINISH FLOOR WITH [illegible] AND BROOM FINISH. APPLY CONCRETE CURING COMPOUND.
13. REMOVE TEMPLATE ASSEMBLY AND FORM PLATE 8 HRS MINIMUM AFTER POUR. RESET TEMPLATE AND FORM PLATE AT SUBSEQUENT FOUNDATION. ALLOW CONCRETE TO CURE A MINIMUM OF 3,000 PSI PRIOR TO BEGINNING TOWER ERECTION.
14. PLACE CONCRETE DRAIN GRATE.
15. ALL CONSTRUCTION SHALL BE PERFORMED IN ACCORDANCE WITH SAFE STANDARDS OF THE INDUSTRY.

CONFIDENTIAL
AND PRELIMINARY
EXCLUSIVE PROPERTY OF
PATRICK & HENDERSON, INC.
U.S.A. PATENT # 5,586,417
NOT FOR CONSTRUCTION

PROPRIETARY WARNING

THIS SET NO. ______ ASSIGNED TO: ______

NOT APPROVED FOR CONSTRUCTION

ASSEMBLY VIEW

30' P&H TENSIONLESS FOUNDATION USA PATENT #5,586,417

CONFIDENTIAL

S172

FOUNDATIONS MUST BE DESIGNED FOR THE SITE CONDITIONS OF EACH PROJECT, NOT JUST SELECTED

"Using site-specific design loads and carrying out site-specific wind turbine designs is somewhat in contrast with the current trend within the wind turbine industry. In order to keep down manufacturing costs, the current trend is not to site-optimise wind turbines, but rather to produce a selection of standard wind turbines. The task is then to choose a standard wind turbine from this selection and verify that it is suitable for a given location. The tower and the foundation may still be site-optimised if desirable, and site-specific loads will be required for this purpose. ***The foundation design will always have to be site-specific in that it needs to be designed for the prevailing local soil conditions.****"*

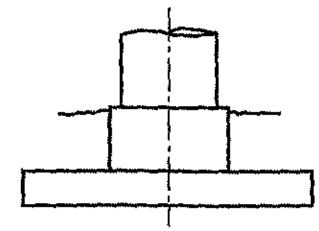
Guidelines for Design of Wind Turbines, 2nd ed. – DNV/Risø

FOUNDATIONS MUST BE DESIGNED FOR THE SITE CONDITIONS OF EACH PROJECT, NOT JUST SELECTED

"Foundation designs are integrated into the type certification for some turbines. Where this is the case, the ***foundation design must be evaluated for the external conditions for which it is intended**. **Poor geotechnical investigation and foundation design have led to delays and cost overruns** at European wind farms (Gerdes et al. 2006)."*

Structural Integrity of Offshore Turbines – Oversight of Design, Fabrication and Installation, TRB Special Report 305, 2011

DESIGN STEPS/CHECKS FOR SHALLOW FOUNDATIONS



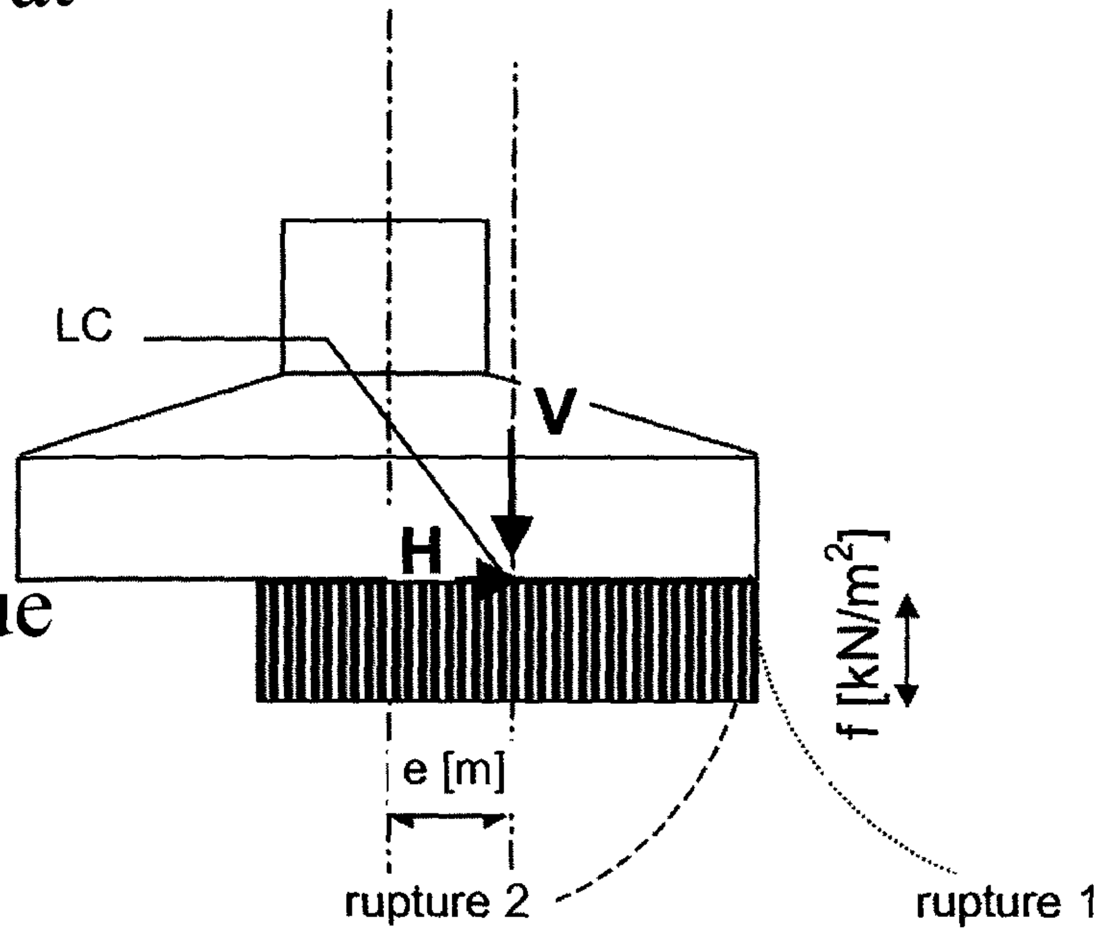
1. Minimum embedment below frost depth
2. Bearing capacity
3. Settlements: Elastic, Consolidation and Differential
4. FS against sliding and overturning
5. Structural design of foundation (typ. reinforced concrete)
6. Drainage
7. Foundation stiffness accounting for modulus degradation due to cyclic loading
8. Dynamic analysis for avoiding resonance of soil-foundation-structure system
9. Scour and erosion (for offshore foundations)

BEARING CAPACITY: ECCENTRICITY OF LOAD

- Design loads V, H act at the foundation base

- Eccentricity e = M/V

- H is reduced if a torque M_z acts about vertical axis (see DNV/Risø Guidelines)

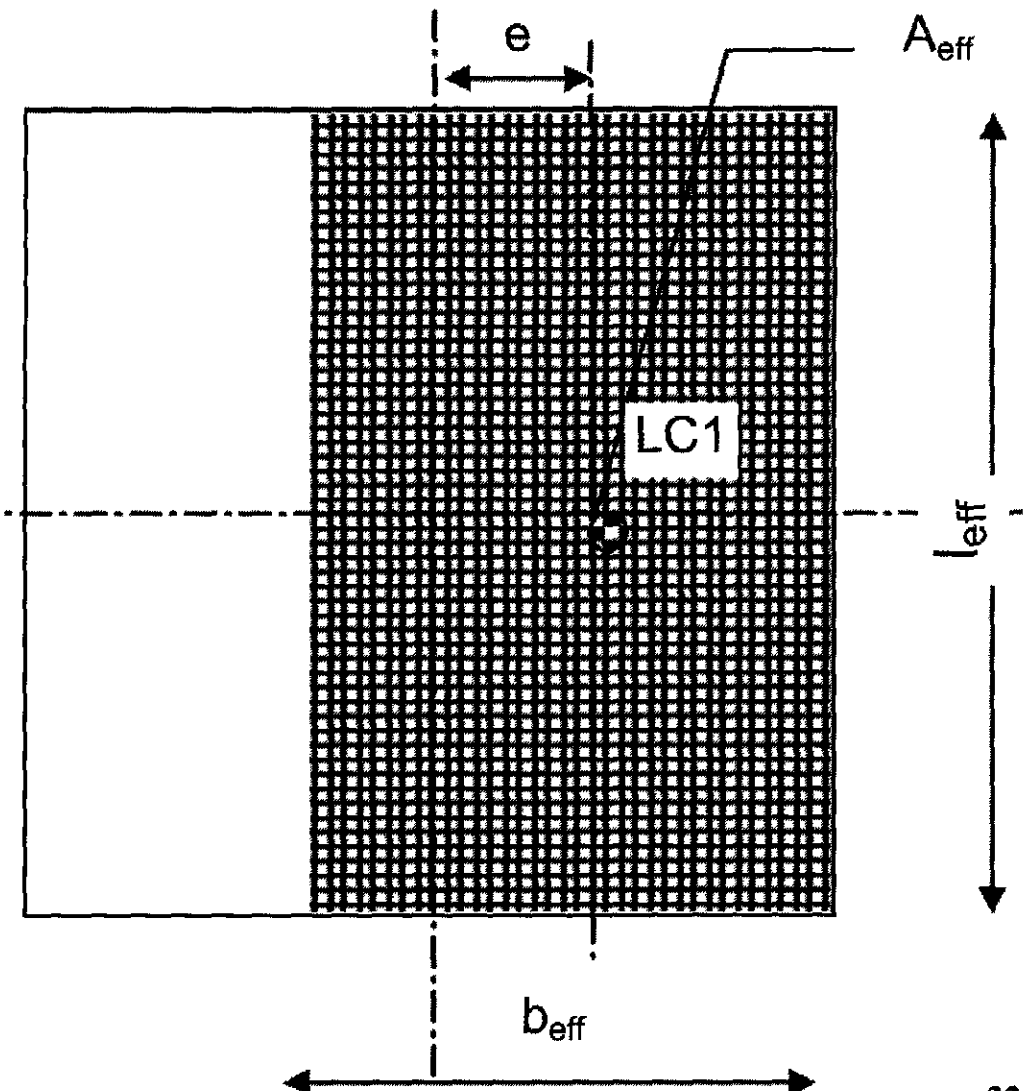


BEARING CAPACITY: EFFECTIVE AREA FOR ECCENTRIC LOAD

Reduced effective foundation area $A_{eff} = b_{eff}\, l_{eff}$ is defined such that the eccentric vertical load is at the center of the effective area:

$$b_{eff} = b - 2e$$

$$l_{eff} = b$$

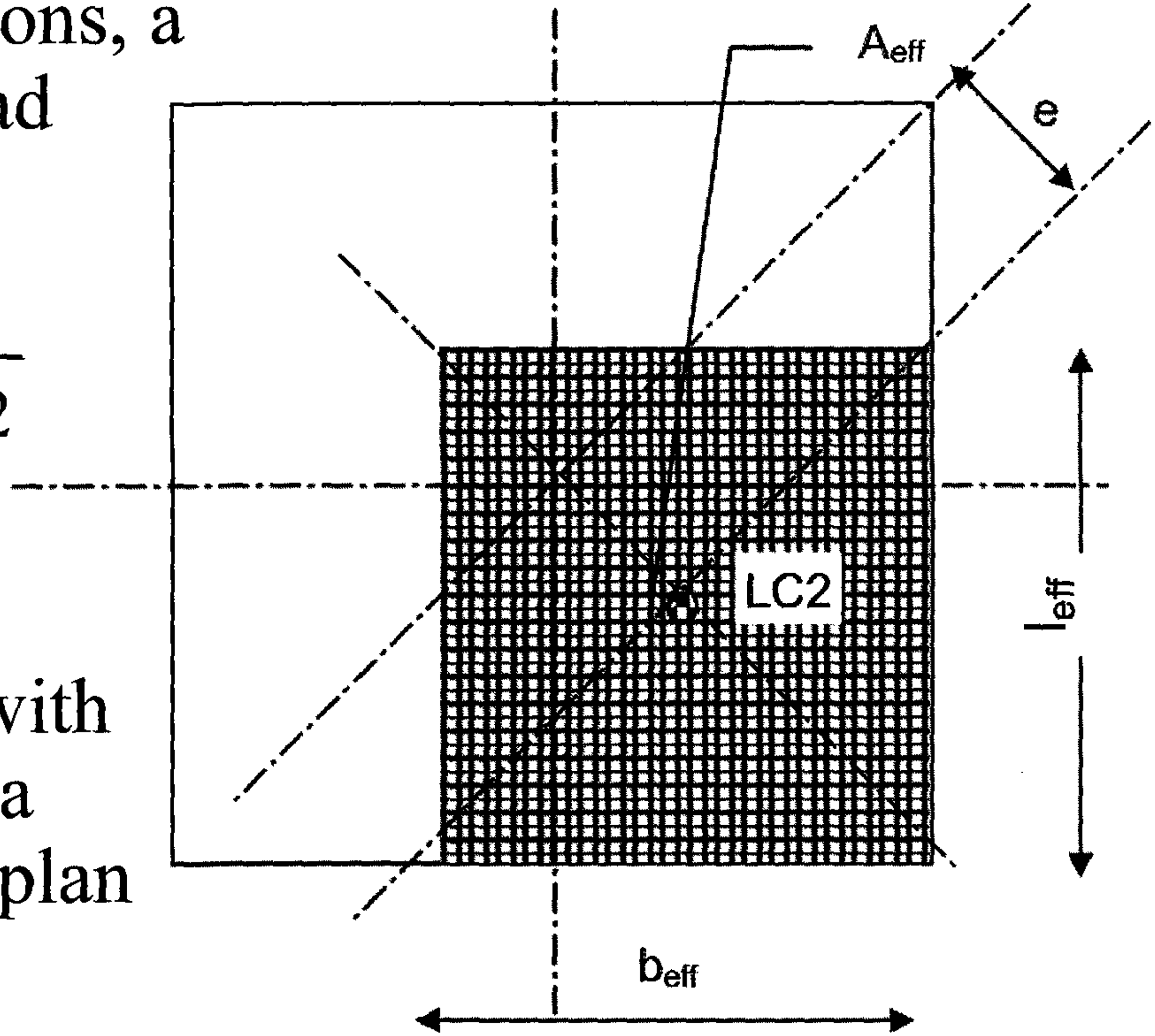


BEARING CAPACITY: EFFECTIVE AREA FOR DOUBLY ECCENTRIC LOAD

- For square foundations, a doubly eccentric load further reduces the effective area:

$$b_{eff} = l_{eff} = b - e\sqrt{2}$$

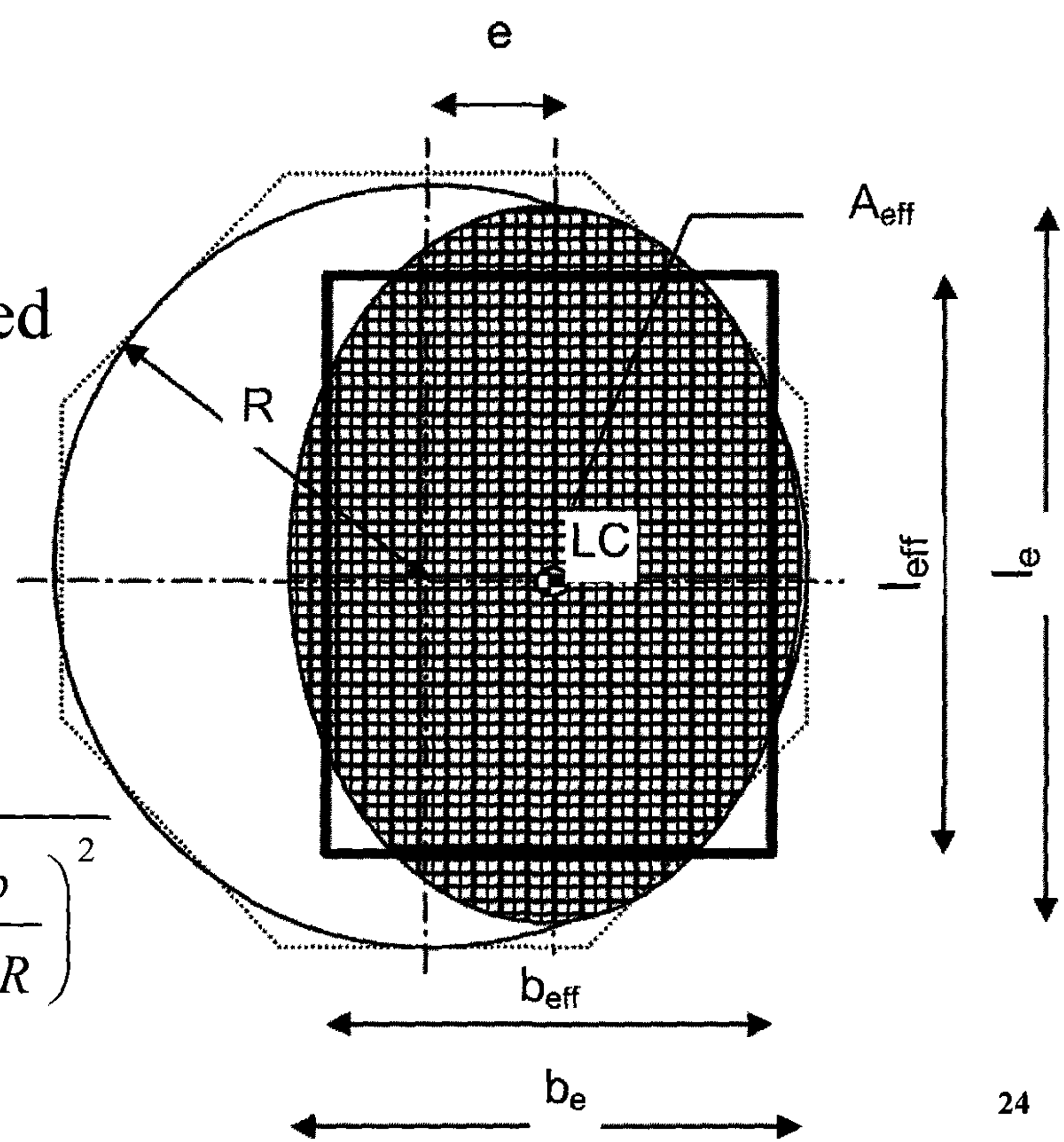
- Since direction of eccentricity varies with nacelle orientation, a circular foundation plan is the most efficient



BEARING CAPACITY: EFFECTIVE AREA FOR ECCENTRIC LOAD ON OCTAGONAL/CIRCULAR FOUNDATIONS

- Octagonal foundation is more practical for construction
- Ellipse is used for reduced area:

$$A_{eff} = 2\left[R^2 \cos^{-1}\left(\frac{e}{R}\right) - e\sqrt{R^2 - e^2}\right]$$



Major axis: $l_e = 2R\sqrt{1-\left(1-\frac{b}{2R}\right)^2}$

Minor axis: $b_e = 2(R-e)$

BEARING CAPACITY: EFFECTIVE AREA FOR ECCENTRIC LOAD ON OCTAGONAL/CIRCULAR FOUNDATIONS

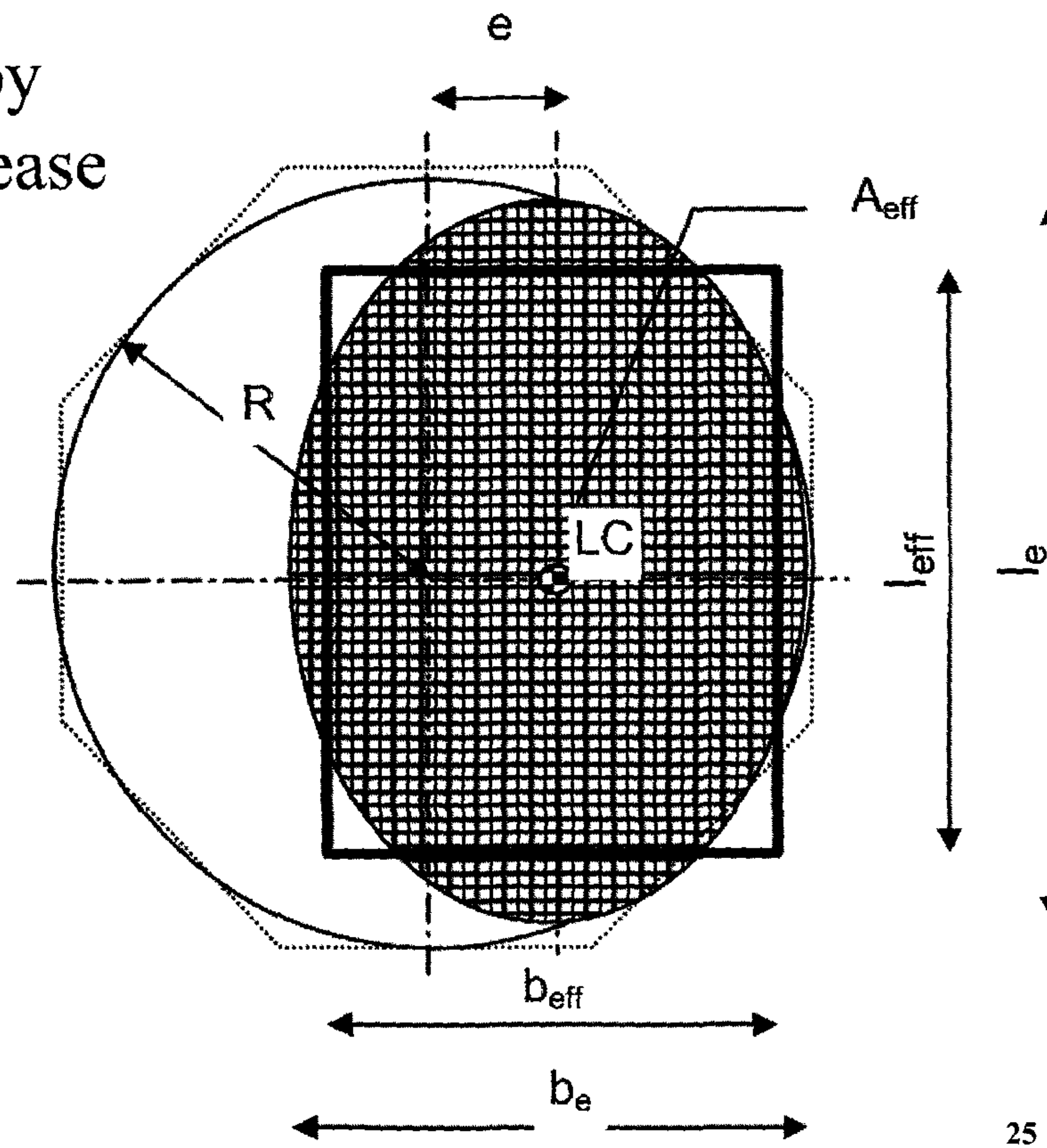
- Ellipse can be replaced by equivalent rectangle for ease of design calculations:

Take

$$b_{eff} = l_{eff} \frac{b_e}{l_e}$$

then

$$l_{eff} = \sqrt{A_{eff} \frac{l_e}{b_e}}$$



BEARING CAPACITY

- Fully drained (long-term) conditions:

$$\boxed{q_{ult} = c'N_c + q'N_q + \frac{1}{2}\gamma' b_{eff} N_\gamma}$$

- Undrained (short-term or rapid loading) conditions in clay:

$$\phi_u = 0, \; N_\gamma = 0, \; N_q = 1,$$

$$\boxed{q_{ult} = c_u N_c + q}$$

- Generally need to apply shape, depth, & inclination factors as well

SETTLEMENT

- Total settlement $S_T = S_e + S_c + S_s$
  - S_e = Elastic settlement (immediate). Most important for sands.
  - S_c = Consolidation settlement; due to squeezing out of water and air from pore space. Most important for clays, small for sands. Can take years to complete. <u>Rate</u> and <u>amount</u> of settlement determined from consolidation theory combined with lab tests.
  - S_s = Secondary settlement; long-term rearrangement of soil structure under constant effective stress. Magnitude depends on mineral types present in soil

FS AGAINST SLIDING

$$F_s = \frac{\Sigma(\text{hor. resisting forces})}{\Sigma(\text{hor. driving forces})} = \frac{c_b \cdot A_{eff} + V \tan \delta_b}{H} \geq 1.5$$

- c_b = adhesion between soil and foundation, often taken as 1/2 to 2/3 of the soil's cohesion
- δ_b = angle of interface friction between soil & base, often taken as 1/2 to 2/3 of ϕ
- For Undrained conditions in clay, $\phi_u = 0$;

$$F_s = \frac{c_b \cdot A_{eff}}{H} \geq 1.5$$

FS AGAINST OVERTURNING

- Similar to the case of sliding, we can take the ratio of restoring moments to overturning moments:

$$F_s = \frac{\Sigma(\text{restoring moments})}{\Sigma(\text{overturning moments})} \geq 1.5,$$

Loss of contact is usually ensured by keeping $e<B/6$

FACTOR OF SAFETY AGAINST OVERTURNING

$F_S < 1.0$

noturbinesin.saddleworth.net

DRAINAGE

- Needed to maintain the design bearing capacity as calculated based on the assumed maximum water table elevation

- Can be provided by using drainage “tiles”, free-draining backfill, and sloping the finished grade away from foundation to prevent ponding

- Excessive wetting of clay soils can cause expansion → differential settlements

- Excessive drying of clay soils (e.g. from nearby vegetation) can cause shrinking →settlements

DYNAMIC ANALYSIS: COUPLED SOIL-STRUCTURE INTERACTION

"A complete natural frequency analysis shall be performed for the combined structure consisting of turbine, tower, tripod and piles" ***[and soil]***. *For this purpose, the non-linear soil must be linearized. It is to be verified that the lowest frequencies differ from at least ±10% of the 1P and 3P rotor frequencies at nominal power."*

Guidelines for Design of Wind Turbines, 2nd ed. – DNV/Risø

DYNAMIC ANALYSIS:
COUPLED SOIL-STRUCTURE INTERACTION

"The dynamics and relative stiffness of the supporting structural and foundation components, commonly envisaged as a monotower in shallow water (but which could be a vertical axis system, a floating system, etc.), have an ***interrelationship with the stiffness and rotation frequency and loads of the blades that must be carefully addressed in the design for long-term performance.****"*

Structural Integrity of Offshore Turbines – Oversight of Design, Fabrication and Installation, TRB Special Report 305, 2011

DYNAMIC FOUNDATION STIFFNESS

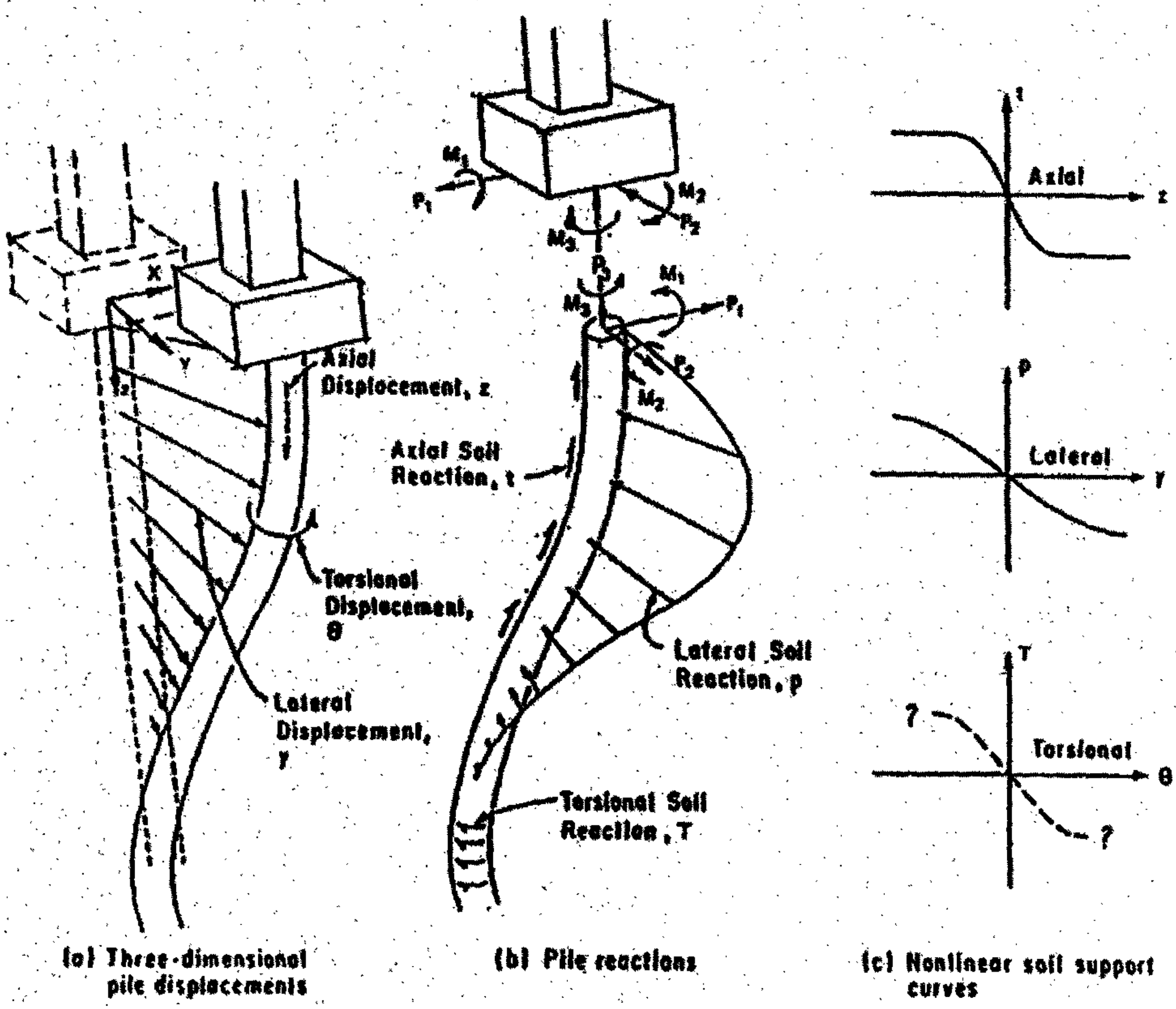
- Dynamic Soil-Structure Interaction (SSI): dynamic soil response affects response of structure and vice-versa
- Stiffness of soil is generally nonlinear and frequency dependent, but often simplified in terms of springs and dashpots
- Stiffness (shear modulus G) and damping (ξ) depend nonlinearly on cyclic shear strain γ_c
- As γ_c increases, G decreases from small-strain value G_{max} while ξ increases
- Design: must use a reduced G based on anticipated shear strain level (typically 10^{-2} to 10^{-3} for wind turbines) in dynamic analysis of soil-foundation-turbine system
- G can then be used to obtain an "equivalent elastic" Young's modulus E for calculating elastic settlements using the reduced foundation area (see Mayne et al. 2002)

Mayne, P.W. et al., "Subsurface Exploration-Geotechnical Characterization", FHWA Publication NHI-01-031, May 2002.

DESIGN OF PILE FOUNDATIONS

More complicated than shallow foundations

Covered in CE 561



Ensoft (1996), *Computer Program Group 4.0 User's Manual*

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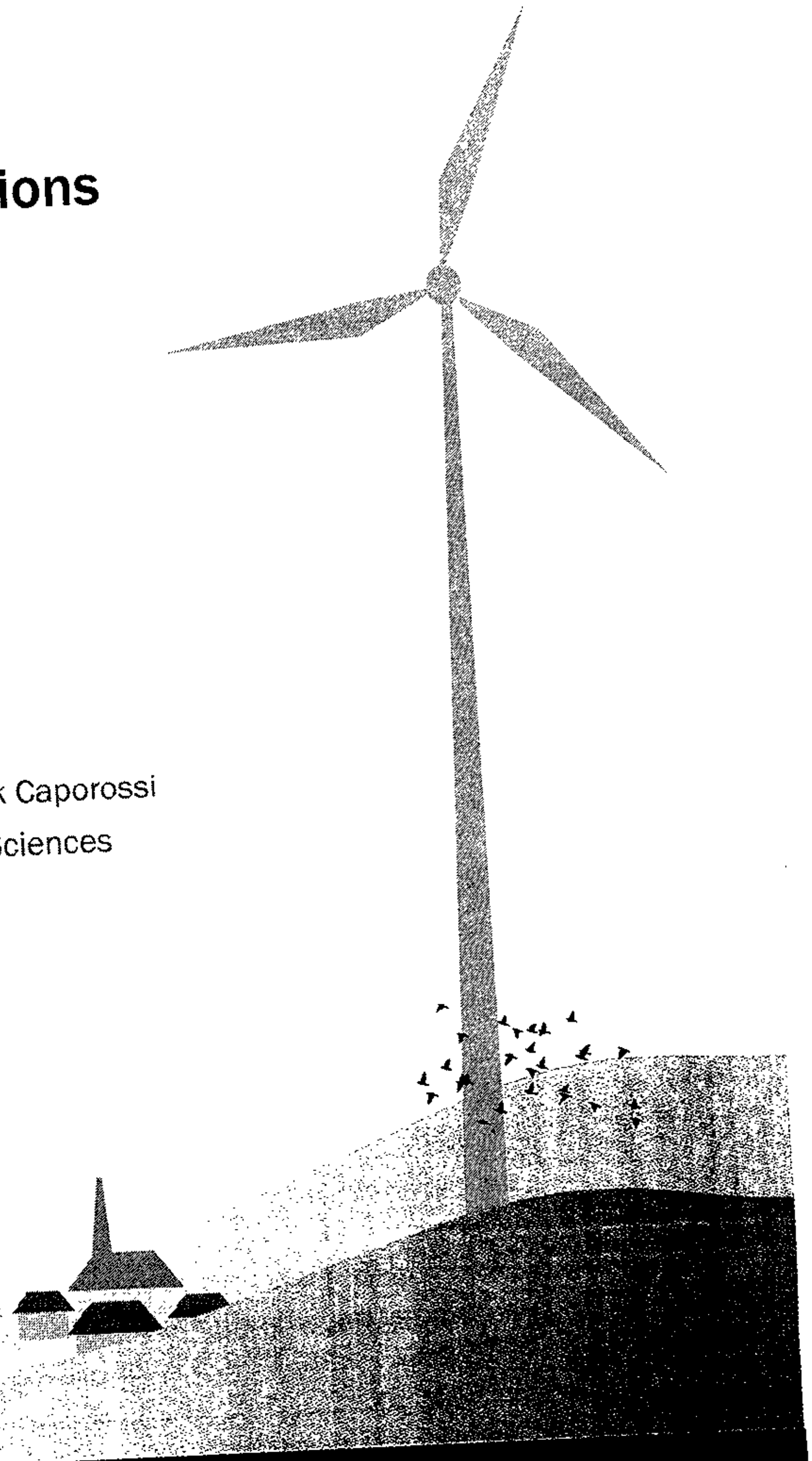
A Guide to Drafting Wind Turbine Regulations



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Manomet Center for Conservation Sciences

September, 2013

MANOMET
Center for Conservation Sciences

Table of contents

Acknowledgements

The Manomet Center would like to thank the following partners for their help in directing this research, identifying important wind development issues and shaping the final document to be as helpful as possible to community level planners:

First Wind Energy, LLC

Hingham Energy Action Committee, MA

The Office of Sen. Robert Hedlund (Assistant Minority Leader of MA State Senate)

Massachusetts Military Reservation

Plymouth Planning Committee, MA

Suffolk University Law School, Boston, MA

We thank our interns, Mark Higgins and Ashley Hill, for their considerable contribution during the research phase of this project.

We would also like to thank Dave Cowan (First Wind Energy, LLC), Sean Mahoney (Conservation Law Foundation) and Jennifer Puser (Greater Portland Council of Governments), for reviewing this guide.

Funding to support this work was gratefully received from the Dorr Foundation, Portsmouth, New Hampshire.

Executive Summary

This guide is intended as a resource for community level planners who face the task of drafting or revising land-based wind turbine regulations for their municipality. It was developed after Manomet Center staff worked with town planning officials and committees who expressed frustration at the daunting task of drafting wind turbine regulation language.

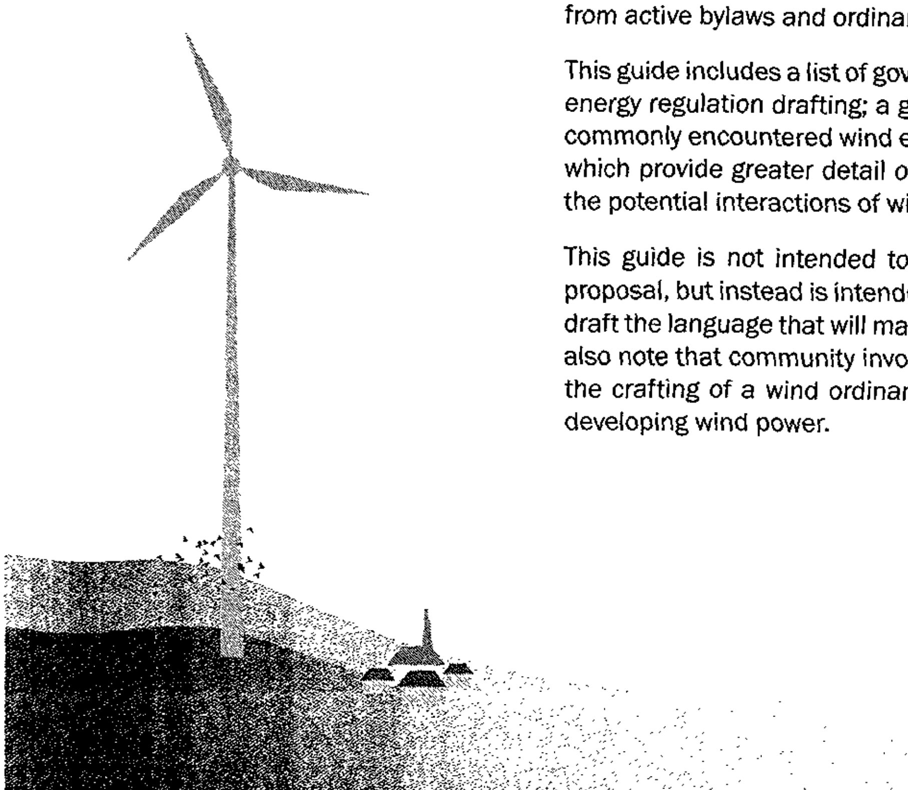
The most important lesson learned from the process is the need for incorporating clear and specific language to avoid confusion and to minimize the potential for loose interpretation of the regulation's intent.

This guide focuses on what Manomet perceives to be the most common issues of concern when municipalities attempt to develop land-based wind turbine regulations for their community, specifically: sound, shadow-flicker, setbacks, height, lighting, scenic impacts, signage and advertising, planning for decommission, and wildlife impacts.

To demonstrate how different levels of regulatory restriction can be achieved on each issue, this guide presents examples of language from active bylaws and ordinances, in addition to bylaw 'models'.

This guide includes a list of government resources of relevance to wind energy regulation drafting; a glossary with definitions for many of the commonly encountered wind energy terminology; and two appendices which provide greater detail on the science of sound and noise, and the potential interactions of wind farms and the environment.

This guide is not intended to work for or against any wind turbine proposal, but instead is intended to help local officials more effectively draft the language that will match their municipality's preferences. We also note that community involvement from the outset is key, for both the crafting of a wind ordinance, and in the subsequent process of developing wind power.



How to use this Guide

This guide is intended as a resource for local officials who face the task of drafting or revising land-based wind turbine regulations for their municipality.

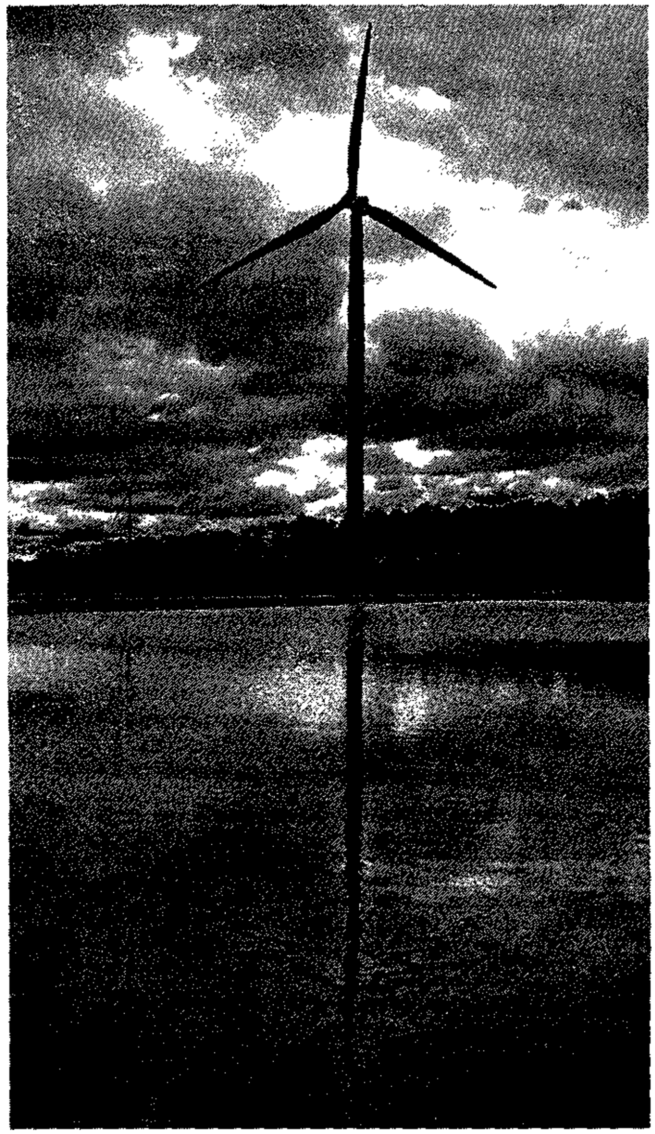
It should be noted that every municipality is different and thus, specific wind development issues will vary from location to location. As such, this guide is not exhaustive or prescriptive, but it does highlight key wind development issues and provides suggestions for addressing each of these.

This guide should not be mistaken for professional legal advice, but it does provide examples of regulatory language that can be inserted into a wind turbine law to achieve different objectives on a specific issue.

This guide is not intended to work for or against any wind turbine proposal, but instead is intended to help local officials more effectively implement their municipality's preferences.

This guide advocates for community involvement from the outset, for both crafting a wind bylaw and during subsequent local wind power development processes. Any potentially controversial planning process works better and will receive most support from the community when all relevant parties are included early in the process. Bylaw drafters are encouraged to engage the community leaders who should be involved in this process and solicit their opinions.

A glossary has been included to provide definitions for many of the commonly encountered terminology when addressing land-based wind farms.



Wind 1 and Wind 2: the two 1.65 MW town-owned wind turbines built in Falmouth, MA. Photo credit: Mark Wilson.

Appendices have also been prepared, which offer detail on the science of sound and noise (Appendix A) and the potential interactions of wind farms and the environment (Appendix B).

The barriers to wind energy development in the United States are more cultural, regulatory, economic or political obstacles than questions about wind quality or engineering feasibility.

This Guide was produced in direct response to municipal-level land use officials who told Manomet staff that drafting wind turbine regulations was a complex challenge that represented a significant departure from their usual planning projects.

We reviewed a variety of approaches to regulating the siting of wind turbines in order to develop a handbook of options for wind turbine bylaw drafters.

Ambiguous language pitfalls

In any regulatory language, ambiguity can cause problems. We recommend avoiding words that are open to wide interpretation at the review level, depending on the perspectives of opposing parties. Examples of ambiguous words or phrasing:

"... **Significant** adverse impact ..."

"... **Excessive** noise generated ..."

"... **Additional benefits** [must] outweigh any increased **adverse** impacts ..."

"... **significant** additional benefits..."

"...**substantial** evidence ..."

"... [that which is] **reasonably** necessary ..."

"... shall be designed to **minimize** land clearing and fragmentation ..."

"... in a manner that does not have **significant** negative impacts on ..."

Throughout this document, we present sample language on different issues, with varying levels of specificity; we recommend adopting the most specific style of language whenever possible.

By right or by special permit

Municipalities have a preference for regulating wind turbines through **special permits** rather than allowing them to be developed **by right.** 'By right' refers to a use permit that requires compliance with existing regulations, but does not require special permission. In contrast, a special permit enables a community to review the location, site development or conduct of wind turbine developments, since these can give rise to conflicts with bordering properties; these special permits are not the automatic right of any applicant.

The form of this requirement and the conditions to meet it differ in implementation, but are always developed with the same basic goal: to regulate wind turbines on a case-by-case basis and with an examination of their particular merits and issues. Regulations overwhelmingly regulate commercial scale wind energy conversion systems through the use of a special permit. Some regulations extend that to all wind turbines, while others allow a carve-out for residential scale wind turbines (as defined in the bylaw). Some regulations that provide for special permits also include the reasoning and goals for that tool.

Example of a special permit

"A Special Permit may be granted if the Special Permit Granting Authority finds that: (a) the specific site is an appropriate and approved location for such use; (b) the use is not expected to adversely affect the neighborhood; (c) there is not expected to be any appreciable hazard to pedestrians, vehicles or wildlife from the use; (d) adequate and appropriate infrastructure will be provided for the proper and safe operation of the Community-Scale Wind Facility; and (e) the requirements of section 616.3-616.10 are complied with in all respects."

Town of Duxbury Zoning Bylaw § 616.3
Duxbury, MA

Other bylaws do not include goals in their requirement for a special permit, intending either that the conditions set forth in the bylaw will satisfy any such concerns or cross-referencing a purpose section usually placed at the beginning of the bylaw.

Wind overlay districts

It is possible to further restrict the area of a town or city that can be developed.

A Wind Overlay District (WOD) is a clearly defined area that is preapproved for wind development. No building of wind turbines can take place outside of the town's Wind Overlay District and no building can take place within the Wind Overlay District unless by either a Special Permit or a General Permit, depending on the WOD.

Interaction of wind turbine regulations and other regulations

Wind turbine regulations are not developed in a regulatory vacuum. Federal and State regulations should be reviewed and thoroughly understood before a municipality drafts their own ordinance or guidelines.

The interaction of other pre-existing codes and wind turbine regulations varies widely among municipalities. Some towns and cities rarely mention other regulatory concerns in their wind turbine regulation, while others explicitly require applicants to follow specific regulations for specific concerns. Local regulations tend to defer to overarching State or Federal authorities for issues such as:

- the structural safety of the wind turbine itself,
- certification by the manufacturer that the wind turbine does not improperly interfere with the electromagnetic spectrum,
- ensuring that storm water runoff complies with environmental regulations*,
- adherence to wetlands and environmental codes and historical district regulation*.

By far, the most popular explicitly mentioned codes are building codes or structural safety codes, noise and Federal Communications Commission (FCC) regulations regarding electromagnetic interference. There are two approaches to placing references to other regulatory codes within the statute.

The first is the **catchall provision**, which is generally placed either at the beginning of the statute or at the beginning of the special permit outlines (if the municipality is regulating wind turbines through special permits). Towns typically use a catch-all provision to incorporate pre-existing code or regulation into the new regulations. Such a provision highlights the different concerns the town wants addressed prior to erection.

The second mechanism towns use in order to incorporate other regulatory codes in the statute, is by **explicit mentions** in each area of regulatory concern.

Example of a catchall provision

"Proposed Wind Turbines shall comply with all applicable local, state, and federal requirements including, but not limited to all applicable electrical, construction, noise, safety, environmental and communications requirements."

Cohasset Zoning Bylaws § 19.4.1.
Cohasset, MA

Example of an explicit mention

"Wetlands: Wind energy conversion facilities shall be located in a manner consistent with all applicable local and state wetlands regulations. Wetland buffer areas may be used for the purposes of providing a clear area."

Town of Chester Bylaws § 5.6.4.
Chester, MA

* These are sometimes also addressed in local regulations.

Common issues to address

Every municipality and potential wind turbine site will have its own specific suite of considerations to address, and these may be environmental, economic or cultural.

However, certain issues surface time and again when attempting to evaluate the potential impacts and thus, the acceptability of prospective wind turbine developments. This guide outlines the most common issues, though not in order of priority; the relative importance of each issue will differ on a case-by-case basis.

Wind 1 and Wind 2: the two 1.65 MW town-owned wind turbines built in Falmouth, MA. Photo credit: Mark Wilson.

Sound

One of the most common – and controversial – issues that arises with wind turbine siting is the sound or noise produced by the machines. There is a distinction between the two: sound is a measurable physical phenomenon, while noise is unwanted or annoying sound, which is highly subjective and varies from person to person. However, sound levels generated by wind turbines are not sufficient to damage hearing, or to cause other direct adverse health effects*.

Although the sound produced by wind turbines can easily be measured, the sound that will be experienced at a given distance from a wind power site will vary considerably based upon factors such as wind farm design, the types of turbines used, topography and meteorological conditions. Different residents also report differing levels of sensitivity to the same noise levels, making regulation complex and challenging.

Most bylaws also require the developer to consult the state-level Department of Environmental Protection (or equivalent) for guidance on noise measurement.

For a more in-depth explanation of the science of wind turbine sound and noise, please refer to the Appendix A.

Detailed bylaw

"The *commercial wind energy conversion facility and associated equipment shall conform to* Massachusetts noise regulations (310 C.M.R 7.10) and the provisions of the Gloucester Code of Ordinances Chapter 13: Noise. An Analysis, prepared by a qualified acoustical engineer, shall be present to demonstrate compliance with these noise standards and be consistent with the Department of Environmental Protection guidance for noise measurement."

The City of Gloucester Massachusetts Zoning Ordinance § 5.22.7
Gloucester, MA

General noise requirement

"The wind energy conversion facility and associated equipment shall conform to Massachusetts noise regulations (310 CMR 7.10). An analysis, prepared by a qualified engineer, shall be presented to demonstrate compliance with these noise standards and be consistent with Massachusetts Department of Environmental Protection guidance for noise measurement."

Town of Chester Wind Energy Conversion Facilities Bylaw § 5.7.4
Chester, MA

Bylaw more stringent than state code

"In all residential districts the maximum decibel level at the property line shall be 50 decibels. In all non-residential districts the maximum decibel level at the property line shall be 65 decibels."

City of Taunton Zoning Ordinance § 8.6
Taunton, MA

* CMOPH, (2010). The potential health impacts of wind turbines. Ontario Ministry of Health and Long-term care: Chief Medical Officer of Public Health: 14 pp.

Shadow / Flicker

Shadow flicker occurs when the rotating wind turbine blades cause alternating changes in light intensity and it is measured at various distances from the turbine.

Flicker does not present a health hazard – the speed of the rotating blades are not sufficiently fast to induce an epileptic seizure*. However, individuals living in affected residences have described this phenomenon as a nuisance or an annoyance.

This effect occurs when the sun is low and the rotating turbines are positioned between a location and the sun. As a result, shadow flicker is predictable and can sometimes be mitigated with tree or bush plantings, or suspended turbine operation.

Some municipalities have attempted to set shadow flicker thresholds using the duration of shadow flicker that affects a certain location. These regulators (and a study from the Massachusetts Departments of Environmental Protection and Public Health) cite a German standard of 30 hours of annual shadow flicker*.

Note: All of the local regulations reviewed for this docment included ambiguous language (e.g."significant adverse impact") that could cause conflict at the review level.

Placing burden on applicant

"Shadow/Flicker Wind facilities shall be sited in a manner that minimizes shadowing or flicker impacts. The applicant has the burden of proving that this effect does not have significant adverse impact on neighboring or adjacent uses through either siting or mitigation."

Model As-of-right Zoning Ordinance or Bylaw § 3.10.5
Boston, MA

Placing burden on applicant but prevents rejection for existence of flicker

"Shadow/Flicker – Community-Scale Wind Facilities shall be sited in a manner that minimizes shadowing or flicker impacts caused by motion of the rotor blades as they pass in front of the sun. The applicant has the burden of proving that this effect does not have significant impact on the neighboring or adjacent uses through either siting or mitigation. It is acknowledged that a degree of shadow/flicker effect results from any wind turbine, and that the existence of some "shadow flicker" alone shall not be cause for the refusal to permit a Community-Scale Wind Facility."

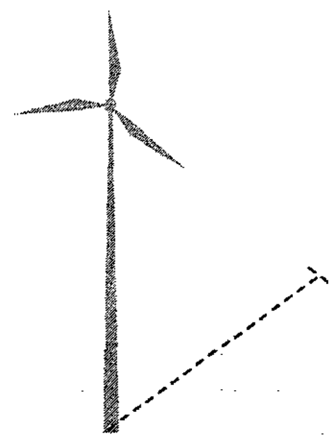
Town of Duxbury Community Scale Wind Facilities Bylaw § 616.6.1
Duxbury, MA

* Massachusetts Clean Energy Center, (2013). Learn About Clean Energy: Shadow Flicker, http://www.masscec.com/content/shadow-flicker. Webpage last accessed: 07.03.2013.

Setbacks

Setbacks are one of the most crucial regulatory tools of wind turbine siting, because they influence many different issues, including visual impact, noise, flicker and safety. Setback is often determined by the distance from the base of the tower to the nearest lot line*.

When determining the minimum setback from the nearest property line, bylaws will often reference the height of the wind turbine. This is typically done from the mean natural grade of the ground supporting the pad(s) to the tip of a blade in vertical position measured along the vertical axis of the tower.



Different setbacks to the nearest structure and nearest property line

"Community-Scale Wind Facilities and or Monitoring or Meteorological Towers shall be set back a minimum distance equal to 1.1 times the overall height of the Wind Facility from the nearest property line and private or public way and a minimum distance equal to two (2) times the overall height of the Wind Facility from the nearest existing residential or commercial structure not owned by the applicant seeking to permit the Community-Scale Wind Facility and or Wind Monitoring or Meteorological Towers."

Town of Duxbury Community Scale Wind Facilities Bylaw § 616.4
Duxbury, MA

Same setback to the nearest structure and nearest property line, also allowing special districts or overlays to fall within setback zone

"Wind Turbines shall be set back a distance equal to 1.1 times the overall height of the wind turbine from the nearest existing residential or commercial structure and from the nearest property line and private or public way. The setback zone can fall within the limits of Wetlands Protection Overlay and the Flood Hazard Overlay Districts."

Town of Duxbury Community Scale Wind Facilities Bylaw § 616.4
Duxbury, MA

Most restrictive setback (tower height)

"Setbacks from adjacent parcels. A minimum setback for each wind facility shall be maintained equal to two times the overall wind turbine height, or 300 feet, whichever is greater, from all boundaries of the site on which the wind facility is located."

Town of Williamstown, Massachusetts: Chapter 70, Zoning Bylaws § 70-G.4.c
Williamstown, MA

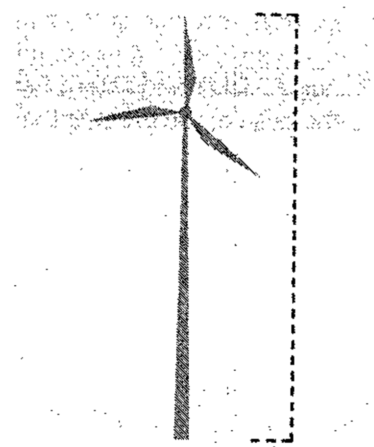
* AWEA, (2013). Learn About Wind Power: State Ordinances. American Wind Energy Association, http://www.awea.org/learnabout/smallwind/CommunityWindPolicy.cfm. Last accessed: 07.13.2013.

Height

The height of a wind turbine is critical to its performance and power generation, because stronger and more consistent winds occur at greater heights*. As such, it is in the interest of the wind developer to build taller wind turbines. Similar to setbacks, however, the height of the turbine can influence a variety of other impacts, most notably the visual impact.

The permissible height of a turbine varies between locations because of pre-existing restrictions in the municipality and – if an airport is nearby – the relevant Federal Aviation Administration (FAA) standards.

When measuring, turbine height is usually defined and measured from the natural grade to the tip of the rotor blade at its highest point; this is often referred to as blade-tip height or maximum tip height. In contrast, tower height refers to the height above grade of the fixed portion of the tower, measured to the top of the nacelle and excluding the wind generator.



Height

No exceptions, height measured to rotor hub instead of blade tip

"Wind facilities shall have a maximum height of 350-feet, as measured from the natural grade to the top of the hub were the rotor attaches."

Town of Cohasset Zoning Bylaws § 19.3.3.1
Cohasset, MA

Restrictive, bans guy wires

"No monopole or attached accessory antenna on a monopole shall exceed 120 feet in height as measured from natural ground level at the base of the pole. No monopole shall be constructed which requires guy wires. Monopoles shall not be located on buildings."

Foxborough Zoning By-Laws § 7.2.4
Foxborough, MA

Permissive, allowing for exceptions to improve turbine performance

"Wind facilities shall be no higher than 400 feet above the current grade of the land, provided that wind facilities may exceed 400 feet if:

(a) the applicant demonstrates by substantial evidence that such height reflects industry standards for a similarly sited wind facility;

(b) such excess height is necessary to prevent financial hardship to the applicant, and

(c) the facility satisfies all other criteria for the granting of a site plan approval and a building permit under the provisions of this section."

Town of Dixmont Wind Energy Facility Ordinance § 5.d
Dixmont, ME

additional example overleaf...

* Maps published by the National Renewable Energy Laboratory in 2011 for wind resources at 30 m and 80 m; http://www.windpoweringamerica.gov/wind_maps.asp. Last accessed 07.13.2013.

Height (continued)

Allowing for exceptions with maximum height

Note: wording is ambiguous and thus, is not ideal, e.g. "significant" and "substantial"

"Wind Turbines shall be no higher than 350 feet above existing average grade, measured to the tip of the rotor blade at its highest point. The SPGA may allow said height to exceed to a maximum of 525 feet, but only if the applicant can demonstrate that:

(a) The additional benefits of a higher wind turbine outweigh any increased adverse impacts resulting therefrom.

(b) A higher wind turbine will result in significant additional benefits in terms of energy production and efficiency.

(c) As shown by substantial evidence, such increased height reflects the industry standard for a wind turbine with a similar rates nameplate capacity and

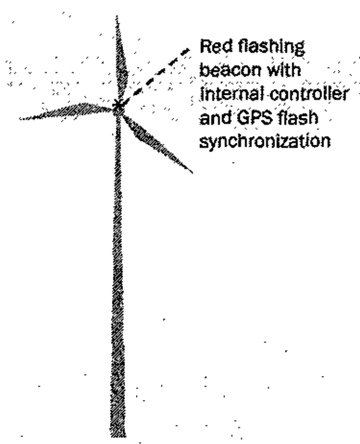
(d) That the proposed wind turbine satisfies all other criteria for the granting of a special permit as set forth in this section."

Zoning By-Law Town of Douglas, Massachusetts § 6.7.5
Douglas, MA

Lighting

Turbine lighting is often required for airplane safety. In some situations, however, it can be an annoyance to neighbors and a hazard to wildlife. For example, lighting on operation and maintenance buildings, electrical substations and other attendant features of a wind farm installation that have outdoor lighting, such as, flood lighting.

Most regulatory language explicitly requires turbine developers to comply with federal FAA regulatory language. It could further require that the best available technology is used. For example, it is possible to install radar-triggered lighting (e.g. OCAS, The Obstacle Collision Avoidance System, and similar) that activates only when approaching aircraft are detected, thereby minimizing light pollution at other times. These technologies have been approved by aviation authorities in Norway, Sweden, Canada and the US and are installed in more than 60 locations in Europe and North America.



Lighting

Bans lighting unless required by law

"Wind Turbines shall not be artificially lighted, except to the extent required by law, and strobe or other intermittent lights are prohibited unless required by law."

Town of Dixmont Wind Energy Facility Ordinance § 5.d
Dixmont, ME

Bans lighting unless required by law, simplest language

"Wind Energy Facilities shall not be artificially lighted, except to the extent required by the Federal Aviation Administration or other applicable authority that regulates air safety."

An Ordinance Amending the Valley Township Zoning Ordinance in order to provide for the installation and use of wind energy facilities within the Township § 431.A.5
Valley Township, Montour County, PA

Lighting (continued)

Bans lighting unless required by law, requires FAA documentation

"A small wind energy system shall not be artificially lit unless such lighting is required by the Federal Aviation Administration (FAA). If lighting is required, the applicant shall provide a copy of the FAA determination to establish the required markings and/or lights for the small wind energy system".

Small Wind Energy Ordinance § 22.4.8
Nelson County, VA

Compliance with FAA requirements, requires documentation

§ 6.6.5 Night lighting of towers shall be prohibited unless required by the FAA. Lighting shall be limited to that needed for emergencies and/or required by the FAA.

§ 6.9.7 Lighting and Signage.

a. Wind turbines shall be lighted only if required by the Federal Aviation Administration (FAA). The proponent shall provide a copy of the FAA's determination to establish the required markings and/or lights for the structure.

b. Lighting of equipment, structures and any other facilities on site shall be shielded from abutting properties.

City of Salem Zoning Ordinance
City of Salem, MA

Bans lighting unless required by law, includes specific lighting and plan

§ 14.1.3 "Wind Turbines shall not be artificially lighted, except to the extent consistent with Federal Aviation Administration recommendations or other applicable authority that regulates air safety or as is otherwise required by another governmental agency with jurisdiction over the WTG."

§ 15.2.7 "Light Pollution. The WTG shall be designed to minimize the amount of nighttime light pollution. The Applicant shall provide a plan showing lighting on and around all Wind Turbines and associated facilities. Lighting on Wind Turbines shall be illuminated to Federal Aviation Administration (FAA) minimal standards using only red rather than white lights, if possible. The minimum number of Wind Turbines will be illuminated, per FAA rules. Lighting shall be shielded from ground view to FAA maximum standards."

Town of Montville Wind Turbine Generator Ordinance
Town of Montville, ME

Bans lighting unless required by law, requires plan, precludes changes without approval

§ 5.1 "Notwithstanding the requirements of this Section, replacement in kind or modification of a Wind Energy Facility may occur without Town Board approval when there will be [...] (3) no additional lighting or change in facility color; ...."

Within an Application for Special Use for individual WECs, there shall be a:

§ 11.A.8 "Lighting Plan showing any FAA-required lighting and other proposed lighting. The application should include a copy of the determination by the Federal Aviation Administration to establish required markings and/or lights for the structure, but if such determination is not available at the time of the application, no building permit for any lighted facility may be issued until such determination is submitted."

§ 13.D "Lighting of Tower. No tower shall be lit except to comply with FAA requirements. Minimum security lighting for ground level facilities shall be allowed as approved on the Site plan."

§ 29.F "Exterior lighting on any structure associated with the system shall not be allowed except that which is specifically required by the Federal Aviation Administration."

Model Wind Energy Facility Local Law for St. Lawrence County Municipalities (DRAFT)
St. Lawrence County, NY

Scenic impacts

Concerns over the scenic or visual impacts of wind turbines on the landscape are common. In order to reduce the visual disturbance of a wind turbine development, some regulations require visual impact assessments to be undertaken and submitted as part of the application. Some municipalities also restrict the paint colors and surface types used in installations, and visual setbacks can also be imposed.

Requires demonstration that visual impact will be minimized, but language is vague and not ideal

"Design Standards: 1. Visual Impact - The proponent shall demonstrate through project siting and proposed mitigation that the wind energy conversion facility minimizes any impact on the visual character of surrounding neighborhoods and the community. This may include, but not be limited to, information regarding site selection, turbine design, buffering, lighting and cable layout."

Town of Chester Wind Energy Conversion Facilities Bylaw § 5.7.4
Chester, MA

Requires visual impact study, visual impact mitigation, specific colors and surface types for the turbine, restricts signage and advertising, encourages screening

11.A.16.b - Visual Impact: Applications shall include a visual impact study of the proposed WECS as installed, which may include a computerized photographic simulation, demonstrating any visual impacts from strategic vantage points. Color photographs of the proposed Site from at least two locations accurately depicting the existing conditions shall be included. The visual analysis shall also indicate the color treatment of the system's components and any visual screening incorporated into the project that is intended to lessen the system's visual prominence.

13.e - All applicants shall use measures to reduce the visual impact of WECSs to the extent possible. All structures in a project shall be finished in a single, non-reflective matte finished color or a camouflage scheme. Individual WECSs within a Wind Overlay Zone• shall be constructed using wind turbines whose appearance, with respect to one another, is similar within and throughout the Zone, to provide reasonable uniformity in overall size, geometry, and rotational speeds. No lettering, company insignia, advertising, or graphics shall be on any part of the tower, hub, or blades.

And for Small WECS

29 d - D. The system's tower and blades shall be painted a non-reflective, unobtrusive color that blends the system and its components into the surrounding landscape to the greatest extent possible and incorporate non-reflective surfaces to minimize any visual disruption.

E. The system shall be designed and located in such a manner to minimize adverse visual impacts from public viewing areas (e.g., public parks, roads, trails). To the greatest extent feasible a small wind energy system shall use natural landforms and vegetation for screening.

Model Wind Energy Facility Local Law for St. Lawrence County Municipalities (DRAFT)
St. Lawrence County, NY

Allows the option for visual setbacks

E. Environmental and Visual Effects:

Optional add-on: Visual setbacks. WECS should be set back from the tops of visually prominent ridgelines and designed and located to minimize adverse visual impacts to neighboring residential areas. WECS shall not be installed in any location that would substantially detract from or block the view of all or a portion of a recognized scenic vista as viewed from any public viewing areas such as public parks, roads, trails, or open space.]

Model Municipal Wind Siting Ordinance, Center for Climate Change Law at Columbia Law School,
New York, NY

Signage and advertising

As a means of reducing the visual disturbance of a wind turbine development, some regulations restrict visual signage and advertising associated with the project.

Refers to existing regulations, safety and encourages signs on renewable energy

"Signs on the facility shall comply with the City of Salem's sign regulations and be limited to those needed to identify the property and the owner and warn of any danger, and educational signs providing information on the technology and renewable energy usage.

[...] Warning signs indicating voltage must be placed at the base of all ground/base mounted electrical equipment."

City of Salem Zoning Ordinance § 6.9.7
City of Salem, MA

Requires plan, safety and contact information, restricts other signs

§ 5.C "A complete assessment of the proposed use of public ways in the Town in connection with the construction of the WEF, including [...] the need to remove or modify (permanently or temporarily) signs, ..."

§ 5.I "An Application for a WEF Site Permit shall include a sign plan meeting the requirements in this section.

(1) The plan shall provide reasonable signage at the WEF, identifying the Project Parcels as being part of the WEF and providing appropriate safety notices and warnings.

(2) No advertising material or signage other than warning, equipment information or indicia of ownership shall be allowed on the Wind Turbines. This prohibition shall include the attachment of any flag, decorative sign, streamers, pennants, ribbons, spinners or waving, fluttering or revolving devices, but not including weather devices.

(3) The address and phone number of the Owner/operator and Licensee shall be posted on all access points from public roads."

§ 5.K "Warning signs shall be placed on each tower, all electrical equipment, and each entrance to the WEF."

Town of Dixmont Wind Energy Facility Ordinance
Dixmont, ME

Restricts advertising, requires safety signage (detailed)

§ 13.C "No advertising signs are allowed on any part of the Wind Energy Facility, including fencing and support structures."

§ 14.C "Appropriate warning signs shall be posted. At least one sign shall be posted at the base of the tower warning of electrical shock or high voltage. A sign shall be posted on the entry area of fence around each tower or group of towers and any building (or on the tower or building if there is no fence), containing emergency contact information, including a local telephone number with 24 hour, 7 day a week coverage. The Town Planning Board may require additional signs based on safety needs."

§ 29.J "At least one sign shall be posted on the tower at a height of five feet warning of electrical shock or high voltage and harm from revolving machinery. No brand names, logo or advertising shall be placed or painted on the tower, rotor, generator or tail vane where it would be visible from the ground, except that a system or tower's manufacturer's logo may be displayed on a system generator housing in an unobtrusive manner."

Model Wind Energy Facility Local Law for St. Lawrence County Municipalities (DRAFT)
St. Lawrence County, NY

Restricts signs, requires safety signage (succinct)

"All signs, temporary and permanent, are prohibited on the small wind energy system, except:

a) Manufacturers/installer identification on the wind turbine, or

b) Appropriate warning signs and placards."

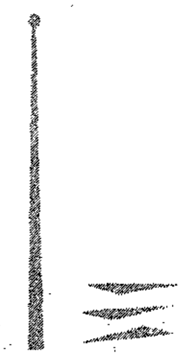
Small Wind Energy Ordinance § 22.4.7
Nelson County, VA

Planning for decommission

The planning and siting of a wind turbine facility must necessarily include a plan to decommission and remove it when it reaches the end of its useful life. A financial surety allows a municipality to permit the construction of a wind energy conversion system without risking the cost of removing the structure, should the owner or developer fail to do so.

Of jurisdictions that require a surety, many require developers to put forward 150 percent of the cost of removal determined at the time of the granting of the special permit. The Massachusetts Green Communities Model Bylaw suggests 125 percent*. Some municipalities allow a conservative estimate of salvage value to be used as a portion of meeting the surety value.

A qualified engineer should determine the underlying cost of removal. No municipality surveyed for this project required that the engineer be independent. Sureties are used for both removal of the structure and rehabilitation of the site.



Decommissioning

Does not require surety, requires owner to remove structure

"Once a WECS is designated as abandoned, the owner shall be required to immediately dismantle the installation."

Town of Scituate Zoning Bylaw § 740.7. Scituate, MA

Requires 150% surety with increases built in

"Developer must put up 150% surety against removal of the structure at the time of granting the special permit. The surety must include Cost of Living increases at 10 and 15 years."

Town of Chester Wind Energy Conversion Facilities Bylaw § 5.7.8. Chester, MA

Requires surety with increases, does not specify amount

"Applicant, upon obtaining a special permit, shall deliver to the Board of Appeals a financial surety, in form and amounts reasonably acceptable to the Board of Appeals, to cover the cost of removal and disposal of the wind facility and the remediation of the landscape in accordance with this subsection. Such financial surety shall be renewed and updated as necessary throughout the life of the wind facility so as to continue to cover the removal, disposal and remediation costs."

Town of Williamstown, Massachusetts: Chapter 70, Zoning Bylaws § 70-7.2.7. Williamstown, MA

Allows salvage value to be factored into surety amount, and updated annually

22.4 An independent and certified Professional Engineer shall be retained to estimate the total cost of decommissioning without regard to salvage value of the equipment ("Decommissioning Costs"), and the cost of decommissioning including the salvage value of the equipment ("Net Decommissioning Costs"). Said estimates shall be submitted to the Town of Montville after the first year of operation and every other year thereafter.

22.5 The Owner/operator shall post and maintain decommissioning funds in an amount equal to Net Decommissioning Costs; provided that at no point shall decommissioning funds be less than one hundred percent (100%) of Decommissioning Costs. The decommissioning funds shall be posted and maintained with a bonding company or Federal or State-chartered lending institution chosen by the Owner/operator and Participating Landowners posting the financial security, provided that the bonding company or lending institution is authorized to conduct such business within the State and is approved by the Town of Montville. No work can begin on the WTG before the decommissioning bond is issued and approved.

Town of Montville Wind Turbine Generator Ordinance. Town of Montville, ME

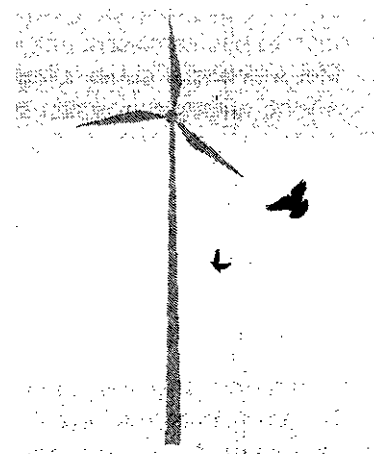
* Green Communities Bylaw. Model As-of-Right Zoning Ordinance or Bylaw. §4.16.8.3, Boston, MA. March 2012.

Wildlife impacts

At a global and regional scale, the effect of wind energy on the environment is generally considered to be positive, given that it will displace mining activities, air pollution, greenhouse gas emissions, and other forms of environmental degradation associated with non-renewable energy production. However, wind energy development is not entirely environmentally benign as it may cause localized environmental impacts including direct collision impacts on birds and bats (Kuvlesky et al, 2007; NRC, 2007) and can fragment wildlife habitat.

For an in-depth explanation of the science of the environmental impact of wind turbines and potential mitigation, please refer to Appendix B.

Many regulations related to wildlife impacts are covered by state or federal regulations. However, some local regulations also address specific environmental issues; following are two examples, though the language in each is not ideal since it is ambiguous at times and thus could pose problems during the review process.



Wildlife impacts

Land clearing

"Land Clearing, Soil Erosion and Habitat Impacts – Clearing of natural vegetation shall be limited to that which is reasonably necessary for the construction, operation and maintenance of the Community-Scale Wind Facility and is otherwise prescribed by applicable law, regulations, and ordinances. Community-Scale Wind Facilities shall be designed to minimize land clearing and fragmentation of open space areas."

Town of Duxbury Community-Scaled Wind Facilities Bylaw § 616.6.3
Duxbury, MA

Land use, rare species

"Land Clearing/Open Space/Rare Species - Wind energy conversion facilities shall be designed to minimize land clearing and fragmentation of open space areas and shall avoid permanently protected open space when feasible. Wind turbines should be sited to make use of previously developed areas wherever possible. Wind energy conversion facilities shall also be located in a manner that does not have significant negative impacts on rare species in the vicinity (particularly avian species, bats, etc.)."

Town of Chester Wind Energy Conversion Facilities Bylaw § 5.7.4
Chester, MA

Land use, rare species

"Wind turbines shall be designed to minimize land clearing and fragmentation of open space areas and avoid permanently protected open space when feasible. Wind turbines should be sited to make use of previously developed areas wherever possible. Wind turbine facilities shall also be located in a manner that does not have significant negative impacts on rare species in the vicinity (particularly Avian species, bats, etc.) as may be applicable law."

Hanover Wind Energy Facilities Bylaw § 6.14.6
Hannover, MA

Resources

Following are resources* which will be of use to municipalities that are preparing bylaws for land-based wind energy developments. This list is not exhaustive, and focuses on Governmental, National and State resources only.

Detailed 'How to' guides on preparing bylaws

- MA DOER, (2012). Model As-of-Right Zoning Ordinance or Bylaw: Allowing Use of Wind Energy Facilities. Dept of Energy Resources (DOER), Massachusetts Executive Office of Environmental Affairs, Boston, MA.
- NH OEP (2008). Model Small Wind Energy Systems Ordinance. NH Office of Energy and Planning, Concord, NH.
- NYSERDA (2005). Wind Energy: Model Ordinance Options. NYS Energy Research & Development Authority, Albany, NY.
- St.Lawrence County Government (2007). Model Wind Energy Facility Local Law for St. Lawrence County Municipalities (Draft). St. Lawrence County Planning Office, St. Lawrence County Government, Canton, NY.
- Sussman, M. & James, J. (2011). Model Municipal Wind Siting Ordinance. Center for Climate Change Law at Columbia Law School, New York, NY.

U.S. Department of Energy National Laboratories

- National Renewable Energy Laboratory: National Wind Technology Center
- Sandia National Laboratories: Wind Energy

Government agencies involved in wind power activities.

- Bureau of Land Management: Wind Energy
- Federal Aviation Administration: Obstruction Evaluation / Airport Airspace Analysis
- Federal Energy Regulatory Commission: Integration of Renewables
- Fish and Wildlife Service: Wind Turbine Guidelines Advisory Committee
- Maine Department of Environmental Protection: Land Wind Power
- Massachusetts Gov. Official Website of the Executive Office of Energy and Environmental Affairs: Wind Energy
- National Oceanic and Atmospheric Administration: Earth System Research Laboratory
- New Hampshire Office of Energy and Planning: Resource Library: Small wind energy systems
- Renewable Energy Vermont: Technologies: Wind
- US Dept. of Energy, Energy Efficiency and Renewable Energy (EERE): Wind Program & Wind Powering America
- Vermont Public Services Department: Renewable Energy - Wind

National Wind Energy Associations and Organizations

- American Wind Energy Association
- American Wind Wildlife Institute
- Bats and Wind Energy Cooperative
- National Wind Coordinating Collaborative
- Union of Concerned Scientists: Citizens and Scientists for Environmental Solutions
- Utility Wind Integration Group

* The electronic copy of this document includes active hyperlinks to each of these resources.

Glossary

The following list of terms has been compiled from a number of active bylaws, in addition to the U.S Fish and Wildlife Service's Land-Based Wind Energy Guidelines (USFWS 2012).

Aerodynamic sound: a noise that is caused by the flow of air over and past the blades of a WTG.

Ambient sound: Ambient sound encompasses all sound present in a given environment, being usually a composite of sounds from many sources near and far. It includes intermittent noise events, such as, from aircraft flying over, dogs barking, wind gusts, mobile farm or construction machinery, and the occasional vehicle traveling along a nearby road. The ambient also includes insect and other nearby sounds from birds and animals or people. The nearby and transient events are part of the ambient sound environment but are not to be considered part of the long-term background sound.

Anemometer: a device for measuring the speed and direction of the wind.

Anthropogenic: Resulting from the influence of human beings on nature.

Avian: Pertaining to or characteristic of birds.

Background sound (L90): refers to the sound level present at least 90% of the time. Background sounds are those heard during lulls in the ambient sound environment. That is, when transient sounds from flora, fauna, and wind are not present. Background sound levels vary during different times of the day and night. Because WTGs operate 24/7 the background sound levels of interest are those during the quieter periods which are often the evening and night. Sounds from the WTG of interest, near-by birds and animals or people must be excluded from the background sound test data. Nearby electrical noise from streetlights, transformers and cycling AC units and pumps etc., must also be excluded from the background sound test data.

Blade Passage Frequency (BPF): the frequency at which the blades of a turbine pass a particular point during each revolution (e.g. lowest point or highest point in rotation) in terms of events per second. A three bladed turbine rotating at 28 rpm would have a BPF of 1.4 Hz. [E.g. ((3 blades times 28rpm)/60 seconds per minute = 1.4 Hz BPF)]

Blade reflection: the intermittent reflection of the sun off the surface of the blades of a Wind Turbine.

Blade throw: Rotor blade fragments released from failed wind turbine blades.

Buffer zone: A zone surrounding a resource designed to protect the resource from adverse impact, and/or a zone surrounding an existing or proposed wind energy project for the purposes of data collection and/or impact estimation.

By right: A use permit that requires compliance with existing regulations but does not require special permission.

Carve-out: Essentially an 'exception to the rule' as defined by a specific bylaw.

Clear area: Area surrounding a wind turbine to be kept free of habitable structures.

Community-scale: Wind energy projects greater than 1 MW, but generally less than 20 MW, in name-plate capacity, that produce electricity for off-site use, often partially or totally owned by members of a local community or that have other demonstrated local benefits in terms of retail power costs, economic development, or grid issues.

Critical Electric Infrastructure (CEI): electric utility transmission and distribution infrastructure, including but not limited to substations, transmission towers, transmission and distribution poles, supporting structures, guy-wires, cables, lines and conductors operating at voltages of 13.8 kV and above and associated telecommunications infrastructure. CEI also includes all infrastructure defined by any federal regulatory agency or body as transmission facilities on which faults or disturbances can have a significant adverse impact outside of the local area, and transmission lines and associated equipment generally operated at

voltages of 100 kV or higher, and transmission facilities which are deemed critical for nuclear generating facilities.

Critical habitat: For listed species, consists of the specific areas designated by rule making pursuant to Section 4 of the Endangered Species Act and displayed in 50 CFR § 17.11 and 17.12.

Cut-in speed: The wind speed at which the generator is connected to the grid and producing electricity. It is important to note that turbine blades may rotate at full RPM in wind speeds below cut-in speed.

Decibel (dB): A dimensionless unit which denotes the ratio between two quantities that are proportional to power, energy or intensity. One of these quantities is a designated reference by which all other quantities of identical units are divided. The sound pressure level (Lp) in decibels is equal to 10 times the logarithm (to the base 10) of the ratio between the pressure squared divided by the reference pressure squared. The reference pressure used in acoustics is 20 MicroPascals.

Displacement: The loss of habitat as result of an animal's behavioral avoidance of otherwise suitable habitat. Displacement may be short-term, during the construction phase of a project, temporary as a result of habituation, or long-term, for the life of the project.

Distributed generation: Energy generation that is located at or near the end-user.

Distributed wind: Small and mid-sized turbines between 1 kilowatt and 1 megawatt that are installed and produce electricity at the point of use to off-set all or a portion of on-site energy consumption.

Emission: Sound energy that is emitted by a noise source (i.e. the WTG) is transmitted to a receiver (i.e. a dwelling) where it is immitted.

Fatality: An individual instance of death.

Fatality rate: The ratio of the number of individual deaths to some parameter of interest, such as megawatts of energy produced, the number of turbines in a wind project, the number of individuals exposed, etc., within a specified unit of time.

Feathering: Adjusting the angle of the rotor blade parallel to the wind, or turning the whole unit out of the wind, to slow or stop blade rotation.

Federal action agency: A department, bureau, agency or instrumentality of the United States which plans, constructs, operates or maintains a project, or which reviews, plans for or approves a permit, lease or license for projects, or manages federal lands.

Footprint: The geographic area occupied by the actual infrastructure of a project such as wind turbines, access roads, substation, overhead and underground electrical lines, and buildings, and land cleared to construct the project.

Frequency: The number of oscillations or cycles per unit of time. Acoustical frequency is usually expressed in units of Hertz (Hz) where one Hz is equal to one cycle per second.

Guy wire: Wires used to secure wind turbines or meteorological towers that are not self-supporting.

Habitat: The area which provides direct support for a given species, including adequate food, water, space, and cover necessary for survival.

Habitat fragmentation: Habitat fragmentation separates blocks of habitat for some species into segments, such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area.

Height, blade-tip: The height of a wind turbine measured from natural grade to the tip of the rotor blade at its highest point. This measure is also commonly referred to as the maximum tip height (MTH), or turbine height.

Height, tower: The height above grade of the fixed portion of the tower, measured to the top of the nacelle and excluding the wind generator.

Height, turbine: The height of a wind turbine measured from natural grade to the tip of the rotor blade at its highest point. This measure is also commonly referred to as the maximum tip height (MTH) or blade-tip height.

Hertz (Hz): Frequency of sound expressed by cycles per second.

Ice throw: accumulated ice buildup on the blades of a wind turbine that is, or can be, thrown during normal spinning or rotation.

Infill: Add an additional phase to the existing project, or build a new project adjacent to existing projects.

Infra-sound: sound with energy in the frequency range of 0-20 Hz is considered to be infra-sound. It is normally considered to not be audible for most people unless in relatively high amplitude. The most significant exterior noise induced dwelling vibration occurs in the frequency range between 5 Hz and 50 Hz.

Lattice design: A wind turbine support structure design characterized by horizontal or diagonal lattice of bars forming a tower rather than a single tubular support for the nacelle and rotor.

Listed species: Any species of fish, wildlife or plant that has been determined to be endangered or threatened under section 4 of the Endangered Species Act (50 CFR §402.02), or similarly designated by state law or rule.

Low Frequency Noise (LFN): refers to sounds with energy in the lower frequency range of 20 to 200 Hz. LFN is deemed to be excessive when the difference between a C-weighted sound level and an A-weighted sound level is greater than 20 decibels at any measurement point outside a residence or other occupied structure.

Mechanical noise: sound produced as a byproduct of the operation of the mechanical components of a WTG(s) such as the gearbox, generator and transformers.

Megawatt (MW): A measurement of electricity-generating capacity equivalent to 1,000 kilowatts (kW), or 1,000,000 watts.

Meteorological tower (MET tower): a meteorological tower used for the measurement of wind speed.

Migration: Regular movements of wildlife between their seasonal ranges necessary for completion of the species lifecycle.

Migration corridor: Migration routes and/or corridors are the relatively predictable pathways that a migratory species travel between seasonal ranges, usually breeding and wintering grounds.

Migration stopovers: Areas where congregations of wildlife assemble during migration. Such areas supply high densities of food or shelter.

Mitigation: (Specific to this context) Avoiding or minimizing significant adverse impacts, and when appropriate, compensating for unavoidable significant adverse impacts.

Mitigation Waiver: a legally enforceable, written agreement between the Applicant and a Nonparticipating

Landowner in which the landowner waives certain setback, noise or other protections afforded in the Ordinance.

Monitoring: 1) A process of project oversight such as checking to see if activities were conducted as agreed or required; 2) making measurements of uncontrolled events at one or more points in space or time with space and time being the only experimental variable or treatment; 3) making measurements and evaluations through time that are done for a specific purpose, such as to check status and/or trends or the progress towards a management objective.

Mortality rate: The numbers of birds or bats killed per turbine per year.

Nacelle: The frame and housing at the top of the tower that encloses the gearbox and generator and protects them from the weather.

Nameplate capacity: the electrical power rating of an individual wind turbine as certified by the manufacturer and normally expressed in watts, kilowatts (kW), or megawatts (MW).

Net metering: The difference between the electricity supplied to a customer over the electric distribution system and the electricity generated by the customer's small wind energy system that is fed back into the electric distribution system over a billing period.

Noise: any unwanted sound. Not all noise needs to be excessively loud to represent an annoyance or interference.

Passerine: Describes birds that are members of the Order Passeriformes, typically called "songbirds."

Plant communities of concern: Plant communities of concern are unique habitats that are critical for the persistence of highly specialized or unique species and communities of organisms. Often restricted in distribution or represented by a small number of examples, these communities are biological hotspots that significantly contribute to the biological richness and productivity of the entire region. Plant communities of concern often support rare or uncommon species assemblages, provide critical foraging, roosting, nesting, or hibernating habitat, or perform vital ecosystem functions. Includes any plant community with a Natural Heritage Database ranking of S1, S2, S3, G1, G2, or G3.

Power grid: The transmission system, managed by ISO New England, created to balance the supply and demand of electricity for consumers in New England.

Project transmission lines: Electrical lines built and owned by a project developer.

Raptor: As defined by the American Ornithological Union, a group of predatory birds including hawks, eagles, falcons, osprey, kites, owls, vultures and the California condor.

Rotor: The parts of a wind turbine that interact with wind to produce energy; the blades and hub of the wind turbine that rotate during turbine operation.

Rotor-swept area: The area of the circle or volume of the sphere swept by the turbine blades.

Rotor-swept zone: The altitude within a wind energy project which is bounded by the upper and lower limits of the rotor-swept area and the spatial extent of the project.

Sensitive receptor: Places or structures intended for human habitation, whether inhabited or not, public parks, state and federal wildlife areas, the manicured areas of recreational establishments designed for public use, including but not limited to golf courses, campgrounds and other nonagricultural state or federal licensed businesses. These areas are more likely to be sensitive to the exposure of the noise, shadow or flicker, etc. generated by a WTG or WTG Facilities. These areas include, but are not limited to: schools, daycare centers, elder care facilities, hospitals, places of seated assemblage, non-agricultural businesses and residences.

Setback: The base of the tower to the nearest property line.

Setback area: The entire land base that falls within a specified setback.

Shadow flicker: Alternating changes in light intensity caused by the movement of wind turbine blades casting shadows on the ground or a stationary object.

Sight line representation: A line depicted in profile extending from an observer's eye to the lowest point of a viewed tower.

Sign: Any word, letter, symbol, drawing, picture, design, device, article or object which advertises, calls attention to or indicates the location of any premises, person or activity; whatever its manner of composition or construction and however displayed.

Small Wind Energy Conversion System ("Small WECS"): A wind energy conversion system (WECS) consisting of a wind turbine, a tower, and associated control or conversion electronics, which has a rated capacity of not more than 100 kW and which will be used primarily for onsite consumption.

Sound: A fluctuation of air pressure which is propagated as a wave through air.

Sound power: The total sound energy radiated by a source per unit time. The unit of measurement is the watt.

Sound pressure: The instantaneous difference between the actual pressure produced by a sound wave and the average or barometric pressure at a given point in space.

Special permit: A special permit is a zoning instrument used primarily to review the location, site development, or conduct of certain land uses. These are uses that may have an impact on the area in which they are located, or are capable of creating special problems for bordering properties unless given special attention. A special permit may be granted at the discretion of the Special Permit Granting Authority (SPGA) and is not the automatic right of any applicant.

Special Permit Granting Authority (SPGA): Board designated by zoning ordinance or bylaw with the authority to issue special permits.

Species of concern: For a particular wind energy project, any species which: 1) is either, a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act; b) is designated by law, regulation, or other formal process for protection and/ or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development; and 2) is determined to be possibly affected by the project.

Species of habitat fragmentation concern: Species of concern for which a relevant federal, state, tribal, and/ or local agency has found that separation of their habitats into smaller blocks reduces connectivity such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area. Habitat fragmentation from a wind energy project may create significant barriers for such species.

String: A number of wind turbines oriented in close proximity to one another that are usually sited in a line, such as along a ridgeline.

Strobe: Light consisting of pulses that are high in intensity and short in duration.

Tonal sound or tonality: Tonal audibility. A sound for which the sound pressure is a simple sinusoidal function of the time, and characterized by its singleness of pitch. Tonal sound can be simple or complex.

Tower: The monopole, guyed monopole or lattice structure that supports a wind generator.

Tubular design: A type of wind turbine support structure for the nacelle and rotor that is cylindrical rather than lattice.

Tower Height: see Height, tower

Turbine height: see Height, turbine.

Utility-scale: Wind projects generally larger than 20 MW in nameplate generating capacity that sell electricity directly to utilities or into power markets on a wholesale basis.

Voltage (low and medium): Low voltages are generally below 600 volts, medium voltages are commonly on distribution electrical lines, typically between 600 volts and 110 kV, and voltages above 110 kV are considered high voltages.

Wildlife: Birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent.

Wildlife management plan: A document describing actions taken to identify resources that may be impacted by proposed development; measures to mitigate for any significant adverse impacts; any post-construction monitoring; and any other studies that may be carried out by the developer.

Wind energy conversion system (WECS): All equipment, machinery and structures utilized in connection with the conversion of wind to electricity. This includes, but is not limited to, all transmission, storage, collection and supply equipment, substations, transformers, site access, service roads and machinery associated with the use. A wind energy conversion facility may consist of one or more wind turbines.

Wind Monitoring or Meteorological ("test" or "met ") Towers: A temporary tower equipped with an anemometer, wind vane and other equipment to measure the wind resource (wind speed and direction), to determine how much electricity a wind energy facility can be expected to generate at a predetermined height above the ground.

Wind Overlay District (WOD): An area within a municipality where wind energy facilities shall be permitted subject to the review and permitting requirements of a wind turbine bylaw for that town; wind turbine development outside of said WOD would not be permitted.

Wind turbine: A machine for converting the kinetic energy in wind into mechanical energy, which is then converted to electricity.

Wind Turbine Flickering: The blinking effect while the rotor is in motion. Attention will be paid to siting the wind turbine(s) to reduce significant flickering.

Wind Turbine Generators (WTG): Equipment that converts and then transfers energy from the wind into usable forms of electrical energy and includes all related and supporting items including but not limited to all buildings, structures, electrical equipment, substations, transmission lines, access roads, parking lots, areas to be stripped or graded, and areas to be landscaped or screened.

Appendix A

The science of sound and noise

Additionally, people's perceptions of sound and reactions to noise are highly variable and subjective (BLM 2004, Rogers et al. 2004, Colby et al. 2009). Given this variability, it is difficult to generalize about the impacts of wind power noise.

To introduce fundamental concepts and terminology used in measurements of sound and noise, an overview of sound and noise is provided below. Questions related to wind turbine noise and its impacts are then addressed. The basics of sound and noise:

Sound is primarily characterized by its intensity, or its 'sound pressure level'. Sound pressure levels are measured in terms of decibels (dB), with 0 dB being the typical threshold of human hearing and 140 decibels being the typical threshold of pain. The decibel scale is based upon a logarithmic function, which means that a 10 dB increase in sound pressure level creates approximately a doubling in loudness (Alberts 2006, NMCPHC 2009).

Sound is also characterized by its frequency, which is measured in hertz (Hz). Although the normal human ear perceives sounds at frequencies ranging from about 20 Hz to 20,000 Hz, human perception of sound is less sensitive to very low and high frequencies, and is generally most sensitive to frequencies between 1,000 and 4,000 Hz. Sound below 200 Hz is considered to be 'low-frequency sound'; low frequency sound is present at low levels throughout the environment (e.g. sound from wind or water). Sound below 20 Hz is described as 'infrasound'; infrasound is generally not audible but it may cause vibration (Rogers et al. 2004, Alberts 2006, Leventhall 2006, NMCPHC 2009, CMOPH 2010).

Frequency influences our perception of sound; for this reason, various scales are used to calibrate sound pressure levels according to frequency. Environmental sounds are generally measured using an A-weighted scale, which accounts for the sensitivity of the human ear and de-emphasizes very high and low frequencies; A-weighted sound pressure levels are measured in units of dB(A) (Rogers et al. 2004, Alberts 2006). For comparison, the sound pressure level produced by rustling leaves is about 45 dB(A), the sound of normal conversation is about 60 dB(A), and the sound of a jet take-off is about 130 dB (A) (Reed College, 2010). Given that wind turbine sound is considered a form of environmental noise, it is generally measured according to the A-weighted scale and is discussed in terms of dB(A) (Rogers et al. 2004, Alberts 2006).

When discussing environmental noise such as wind turbine sound, is important to distinguish between two commonly used sound measurements: sound pressure and sound power.

- **Sound power** is the total acoustic power—or energy converted into sound—emitted by a source; this measurement may be used to estimate how far sound will travel and to predict sound levels at various distances from the source. Sound power is a property of the sound source and is not dependent upon distance.
- **Sound pressure** is the level of sound perceived by an observer. This is a property of the sound at a given observer distance from the source, and will decrease as the sound moves farther from the source.

Sound power and sound pressure measures cannot be compared (Rogers et al. 2004, Alberts 2006).

Perception of sound varies considerably from person to person based upon individual sensitivities. Perception of sound is also influenced the amount of ambient noise (i.e. noise from other sources) that is present; the same level of sound will generally appear to be louder when in a quiet setting than when in a setting with more background noise. For these reasons, responses to sound and noise differ greatly among people and places (Passchier-Vermeer and Passchier 2000, Colby et al. 2009).

Noise is typically measured by peak decibel level and state regulations will be usually be used as the default regulation level. Local regulations cannot place the decibel threshold below state regulations but they can implement a more stringent limit.

Wind turbines produce sound from mechanical as well as the sound of the rotating blades displacing air (typically referred to as a whooshing sound).

There are several options on where to measure the noise level. One of the most popular approaches is to measure the noise at the property boundaries. Local regulations can also set the noise level at the nearest building on abutting properties or at the nearest inhabited residence.

Appendix B

Wind power and the environment

At a global and regional scale, wind energy is generally considered to have a positive effect on the environment, given that it will displace mining activities, air pollution and greenhouse gas emissions associated with fossil fuel-based energy production. However, wind energy development may cause localized environmental impacts on birds, bats, and other wildlife (Drewitt and Langston 2006, NRC 2007, Ledec et al. 2011).

Research is ongoing into both the potential impacts of wind energy development on local ecology, and the ways to mitigate negative effects. Research to date indicates that developing wind power infrastructure can impact local environments, but the impacts will vary significantly depending on the wind farm design and location. For this reason, scientists generally agree that environmental effects should be taken into consideration during the siting and planning of wind farms (Drewitt and Langston 2006, Kuvlesky et al. 2007, NRC 2007, Drewitt and Langston 2008, Ledec et al. 2011).

Commonly expressed concerns and questions about the environmental impacts of wind power development on land are discussed below.

Habitat and terrestrial wildlife impacts

The impact of wind power development on habitat and terrestrial wildlife has, to date, attracted significantly less study than the effect on birds and bats. Experience with similar forms of development suggests, however, that the construction, maintenance and operation of wind power facilities will disturb habitat and, for this reason, may negatively impact wildlife (NRC 2007).

Scientists generally agree that the extent of the disturbance to habitat and surrounding wildlife caused by a wind power facility will depend upon a variety of factors, including the size of the wind power site and the type of ecosystem (Kuvlesky et al. 2007, NRC 2007). Although turbines themselves will cause some impact, it is the associated infrastructure—particularly roads and transmission lines—that will likely present a greater threat to habitat and terrestrial wildlife, especially where this infrastructure causes significant vegetation clearing, habitat fragmentation and soil disturbance (Kuvlesky et al. 2007, NRC 2007). Some analyses suggest that initial disturbance associated with construction will likely be far greater than long-term disturbance (Boone et al. 2005, NRC 2007). However, long-term effects are possible, such as loss of native species due to land clearing, displacement of wildlife due to noise, and vibrational intrusion (Drewitt and Langston 2006, Kuvlesky et al. 2007, Kikuchi 2008).

Birds

Studies indicate that the most common behavioral response of birds is to recognize wind turbines as obstacles and to fly around them. However, some birds do strike wind turbines and this, in turn, often results in bird fatalities (Drewitt and Langston 2006, Kuvlesky et al. 2007, Kikuchi 2008).

Documented rates of collision-related fatalities at onshore wind sites range anywhere from zero to 60 birds/turbine/year; however, the majority of studies estimate collision fatality rates of one or fewer birds/turbine/year (Winkelman 1992, Musters et al. 1996, Langston and Pullan 2003, Erickson et al. 2005, Drewitt and Langston 2006, Hotker et al. 2006, Kuvlesky et al. 2007). It has been suggested that these collisions estimates may be low due to sampling and observer biases (Erickson et al. 2005, NRC 2007, Drewitt and Langston 2008). When adjusted for such biases, estimates of bird fatalities at onshore wind sites typically range from fewer than 1 to 3 birds/turbine/year (Erickson et al. 2005, Drewitt and Langston 2008).

Birds may also collide with offshore wind turbines, although the limited research on bird interactions with offshore wind turbines has generally found high levels of wind turbine avoidance and few bird collisions (Kahlert et al. 2004, Desholm and Kahlert 2005, Energy et al. 2006). Given that there is currently little data on offshore wind turbine strike and mortality rates, it is not possible to draw general conclusions about bird collisions with offshore wind turbines (Wilson et al. 2010).

There are situations where the overall avian mortality associated with wind turbine collisions has caused significant concern. The most commonly cited instance is Altamont Pass Wind Resource Area (APWRA), a large, older wind farm in California. Early research conducted at APWRA estimated that, during the two years of study, up to 567 raptors may have died due to wind turbine collisions (Orloff and Flannery 1992, 1996, Erickson et al. 2005); a more recent analysis suggests that up to 2,710 birds—of which about 1,127 are raptors—are killed annually by APWRA's 5,400 wind turbines (Smallwood and Thelander 2008). High overall kills have also been noted at the Tarifa and Navarra wind farms in Spain (Langston and Pullan 2003). Given that some locations cause significant avian mortality, most scientists agree that wind power development sites must be carefully considered (Langston and Pullan 2003, Drewitt and Langston 2008, Kikuchi 2008, NWCC 2010).

It is important to note that many scientists and interest groups have expressed concern about the lack of peer-reviewed, long-term, standardized, and systematic assessments of avian collisions with wind turbines and suggest that, for this reason, there is still significant uncertainty regarding the potential impact of wind turbine collisions on bird populations (Langston and Pullan 2003, Kikuchi 2008). However, this same concern has been expressed about avian collisions with other man-made structures (e.g. communication towers, buildings, power lines, etc.) and is not isolated to collisions with wind turbines (Drewitt and Langston 2006, Hotker et al. 2006). In light of this, many studies suggest that more emphasis needs to be placed on peer reviewed, systematic, long-term studies of bird collisions with all human structures—including but not limited to wind turbines—in order to provide a more complete estimate of bird mortality due to collision and to improve understanding of how collisions impact bird populations at the local, regional, and global levels (Erickson et al. 2005, Drewitt and Langston 2006, Kikuchi 2008).

In addition to wind turbines, a variety of other human activities and anthropogenic causes are responsible for bird mortality, including cats, automobiles, pesticides and collisions with other man-made structures (Erickson et al. 2005). However, comparisons between different anthropogenic causes of bird fatalities should be approached with caution, given that: a) estimates of bird fatalities from both natural and human-related causes are highly uncertain, and b) different anthropogenic sources of bird mortality cannot be directly compared due to their significant variation in prevalence, geographic location, and other such factors (NRC 2007).

Estimates of bird fatalities due to different anthropogenic sources have been reported by Erickson et al. (2005) and the U.S. Fish and Wildlife Service (2002). These sources indicate that, annually in the U.S., collisions with buildings kill between 97 and 976 million birds; collisions with high-tension lines (e.g. power lines) kill anywhere between 130 million and 1 billion birds; collisions with communication towers kill between 4 and 50 million birds; cars kill up to 80 million birds; toxins and pesticides kill more than 72 million birds; and domestic cats kill hundreds of millions of songbirds and other species. These same studies report that, in 2003, collisions with wind turbines killed between 20,000 and 37,000 birds in the U.S. (see also NRC, 2007).

These numbers suggest that bird deaths due to wind turbine collisions are a small fraction of the total bird deaths due to human-related causes—less than 0.003 percent of anthropogenic bird kills in 2003 according to estimates from Erickson et al. (2005). However, wind turbine strike does impose additional risk to bird populations—particularly local bird communities—and it is likely that this risk will increase as wind power development expands (Drewitt and Langston 2006, NRC 2007, Drewitt and Langston 2008, Kikuchi 2008).

The type of birds that a given wind farm affects vary considerably with the topography of the site and the species dynamics in the area (Drewitt and Langston 2006, 2008). Studies indicate that passerines (songbirds), such as warblers and sparrows, generally compose the majority of turbine-related bird fatalities (Kuvlesky et al. 2007, NRC 2007); about 6 percent of turbine-strike bird fatalities in the U.S. are thought to be raptors, including red-tailed hawks, kestrels, and golden eagles (NRC 2007). While passerine and raptor collisions have attracted the most attention and study, other groups of birds, such as waterfowl and shorebirds, have also been known to collide with turbines (Kuvlesky et al. 2007).

The impacts of turbine collision fatalities on bird populations are complex, and added mortality may impose a greater risk to some types of birds than others. For example, while passerines compose the majority of turbine-related fatalities, they are also the most abundant bird group in the terrestrial ecosystem (NRC 2007). Given their abundance and relatively high reproduction levels, passerines are less likely to be impacted at a population level than are many other species (Kuvlesky et al. 2007, NWCC 2010). By contrast, although raptors compose only about 6 percent of turbine-related fatalities, they have longer life spans and lower reproductive rates than do passerines and, for this reason, are more likely to be impacted by additional mortalities caused by wind turbines (Kuvlesky et al. 2007, Newton 2007).

While some types of birds may be at greater risk than others, there does not appear to be conclusive evidence of large-scale impacts to any particular bird species due to wind turbine strike However, studies generally agree that wind turbines may impact local bird communities, and that the long-term effects of wind turbine collisions on bird populations remain highly uncertain (Drewitt and Langston 2006, Kuvlesky et al. 2007, Drewitt and Langston 2008).

Wind power development may indirectly impact bird populations through habitat change, disturbance, and resultant displacement. Studies generally agree that the construction and operation of wind power facilities does disturb habitat, and that this may adversely impact birds and other wildlife, and potentially lead to habitat loss of habitat. However, the scale and degree of this disturbance is uncertain, and its effects on bird life and habitat are contingent upon site- and species-specific factors, and are, therefore, highly variable (Langston and Pullan 2003, Drewitt and Langston 2006, NRC 2007).

Studies of onshore bird populations have recorded disturbance effects (i.e. reduction in bird use or absence of birds) up to 600m from wind turbines for certain species, such as whooper swans (Larsen and Clausen 2002), pink-footed geese (Larsen and Madsen 2000), and European white-fronted geese (Kruckenberg and Jaene 1999). Similarly, studies of offshore impacts have observed decreased concentrations of certain bird species, such as common eider and common scoter, within certain development sites (Langston and Pullan 2003, Drewitt and Langston 2008). However, studies of displacement and disturbance due to wind power facilities are often inconclusive due to lack of before- and after-development impact assessments, and there is currently little evidence regarding whether birds adjust to wind power development over long periods of time (Langston and Pullan 2003, Drewitt and Langston 2006).

Despite uncertainty about the scope and degree of disturbance and displacement caused by wind power facilities, it is widely recognized that habitat change caused by wind power development may potentially threaten certain bird populations (Langston and Pullan 2003, Drewitt and Langston 2006, Kikuchi 2008).

Bats

The impact of wind power development on bats attracted little attention until the early 2000s, when substantial bat fatalities were observed at wind power sites in Minnesota and West Virginia (Johnson et al. 2004, Kerns and Kerlinger 2004). Since then, increased monitoring efforts have documented bat fatalities at wind power facilities worldwide (Kunz et al. 2007, Arnett et al. 2008, NWCC 2010).

A considerable amount of research has recently been directed at understanding the interaction between bats and wind farms and finding ways to mitigate any negative impacts. It is generally agreed that wind farms do impact bats, although studies indicate that these impacts are both highly variable and site- and species-specific, and much remains uncertain about the extent of these impacts and the long-term implications for bat populations (Kunz et al. 2007, Arnett et al. 2008, Cryan and Barclay 2009, NWCC 2010).

Wind turbines can and do kill bats, and turbine-related bat fatalities have been documented at wind power facilities throughout the U.S. and the world (Kunz et al. 2007, Arnett et al. 2008). Direct collision with wind turbines is thought to be the primary source of bat fatalities due to wind power (Horn et al. 2008). However, recent work by Baerwald et al. (2008) suggests that bat fatalities may also be caused by 'barotrauma', a condition in which the internal organs of bats are damaged by dramatic changes in air pressure created in the near vicinity of rotating wind turbines (Baerwald et al. 2008).

Although the impact of wind power development on bats has generally attracted less attention than has the impact on birds, recent studies suggest that at many wind power sites, the turbine-related mortality rates for bats may be considerably higher than for birds (Kuvlesky et al. 2007, Arnett et al. 2008). Estimated fatality rates range from less than one bat/turbine/year at some sites to over 48 bats/turbine/year in others (Arnett et al. 2008), and it has been suggested that, annually, an average of 3.4 bats are killed per turbine in the U.S. (Johnson et al. 2004). Estimated bat fatalities from different studies cannot be directly compared due to differences in sampling protocols (Arnett et al. 2008); however, research generally indicates that the number of bat fatalities and the species affected varies considerably by region and wind power facility (Kunz et al. 2007, Arnett et al. 2008, NWCC 2010).

The effect of these mortalities on bat communities remains highly uncertain. Bats are long-lived and slow to reproduce, making bat populations susceptible to localized extinctions and vulnerable to negative impacts from added mortality factors (Kuvlesky et al. 2007, Arnett et al. 2008). For this reason, some scientists and conservation groups have expressed concern that bat populations may not be able to withstand the existing rate of turbine-related fatalities and/or increased fatalities due to added wind power facilities. However, significant uncertainty remains regarding the long-term impacts of wind power development on bat populations (Kunz et al. 2007, Arnett et al. 2008, NWCC 2010).

Wind turbines affect many different species of bats but three migratory tree-roosting species compose the majority of bat fatalities reported at wind facilities in North America: the hoary bat, the eastern red bat, and the silver-haired bat (Kunz et al. 2007, Arnett et al. 2008). Other species that have been affected include: the eastern pipestrelle, the little brown myotis, the big brown bat, the northern long-eared myotis, the Brazilian free-tailed bat, and the Seminole bat (Barclay et al. 2007, Cryan and Brown 2007, Kunz et al. 2007, NRC 2007, Arnett et al. 2008). None of the bat species known to be impacted by wind farms are currently classified as endangered or threatened (NWCC 2010).

Recent studies indicate that bat fatalities occur when wind turbine blades are in operation and that bats generally do not collide with stationary blades or wind turbine towers (Arnett et al. 2008, Horn et al. 2008). While it is not certain, it is believed that bats may collide with operational wind turbines as a result of inability to detect moving blades, failure to avoid blades due to insufficient reaction time, or difficulty escaping vortices created by wind turbine operation (Barclay et al. 2007, NRC 2007, Horn et al. 2008). It is also possible that bat mortality is caused by barotraumas, or fatal damage to their internal organs caused by dramatic changes in pressure in the near vicinity of operational wind turbines (Baerwald et al. 2008, Cryan and Barclay 2009). Bat fatalities appear to occur mostly during foraging and feeding rather than when bats are flying by or looking for a place to roost (Kunz et al. 2007, Horn et al. 2008).

Factors that have been identified as possibly influencing the risk of turbine-related mortality include:

- **Season and timing:** the majority of bat fatalities appear to occur within a few hours of sunset, and during mid-summer and early fall (the time of southward bat migration) (Kunz et al. 2007, Kuvlesky et al. 2007, Arnett et al. 2008, Cryan and Barclay 2009).
- **Height of wind turbines:** studies indicate that taller turbines cause more bat fatalities than do shorter turbines, a reasonable conclusion given that most bats fly at altitudes of between 100 and 500 meters (Barclay et al. 2007, Arnett et al. 2008);
- **Weather:** bat fatalities tend to be greater right before or after storms, possibly due to bats flying at lower altitudes as a result of low cloud ceilings, or sensory confusion due to unstable meteorological conditions (Kunz et al. 2007, Arnett et al. 2008); and
- **Wind speed:** some studies suggest that bat fatalities are highest on nights when wind turbines are operational but wind speeds are low (Arnett et al. 2008, Horn et al. 2008, Baerwald et al. 2009).

Most scientists agree that much remains unknown about bat populations and their behaviors, and that more standardized, long-term, and full-season research is needed to better understand how bats interact with wind turbines and the overall impacts of wind power facilities on bat communities (Kunz et al. 2007, Arnett et al. 2008, NWCC 2010).

Wind turbine-related fatality appears to be the dominant adverse impact of wind power development on bats (Kunz et al. 2007, Arnett et al. 2008, NWCC 2010). While concern has been expressed about negative impacts due to habitat loss or disturbance caused by the construction and operation of wind power facilities (see for example, Environmental 2008), significant effects to bats from causes other than direct fatalities do not appear to have been demonstrated.

Given that much remains unknown about bat populations and their migration, foraging, and roosting habits, it is difficult to be certain about how best to avoid and/or mitigate the negative impacts of wind power development. However, during the last decade, a variety of possible mitigation strategies have been identified and studied. Suggested mitigation strategies include:

- **Avoidance of ecologically sensitive areas:** it is suggested that, as with birds, high-risk areas--such as those with large abundances of bats or concentrations of threatened bat species--should be avoided (Arnett et al. 2008);
- **Curtailment of operation during high risk periods:** studies suggest that curtailment of wind turbine operation during high-risk periods--mainly nights with low winds when bats are more likely to be flying (Baerwald et al. 2009), especially during late summer and early fall--may significantly reduce the risk of bat injury or fatality (Kunz et al. 2007, Arnett et al. 2008, Baerwald et al. 2009);
- **Reduction of cut-in speed:** recent research indicates that increasing the minimum wind speed at which turbines begin operating--known as the 'cut in' speed--may reduce bat fatalities by up to 44-93 percent (Arnett et al. 2010). However, it is recognized that this mitigation strategy does incur 'marginal' power loss and increased costs for the wind development company in the form of staff time to set up and implement the mitigation practice (Arnett et al. 2010); and
- **Use acoustic devices to deter bats:** it has been suggested that acoustic devices may be used to deter bats from wind turbines (Spanjer 2006, Arnett et al. 2013). Though being explored as a possible mitigation strategy, no such device is currently available for widespread use at wind farms (Arnett et al. 2013).

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Funding to support this work was gratefully received from the *Dorr Foundation*, Portsmouth, New Hampshire.

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Swarm of dragonflies, other insects spotted on radar over Ohio

POSTED 7:43 PM, SEPTEMBER 10, 2019, BY JEN STEER, *UPDATED AT 09:09PM, SEPTEMBER 10, 2019*

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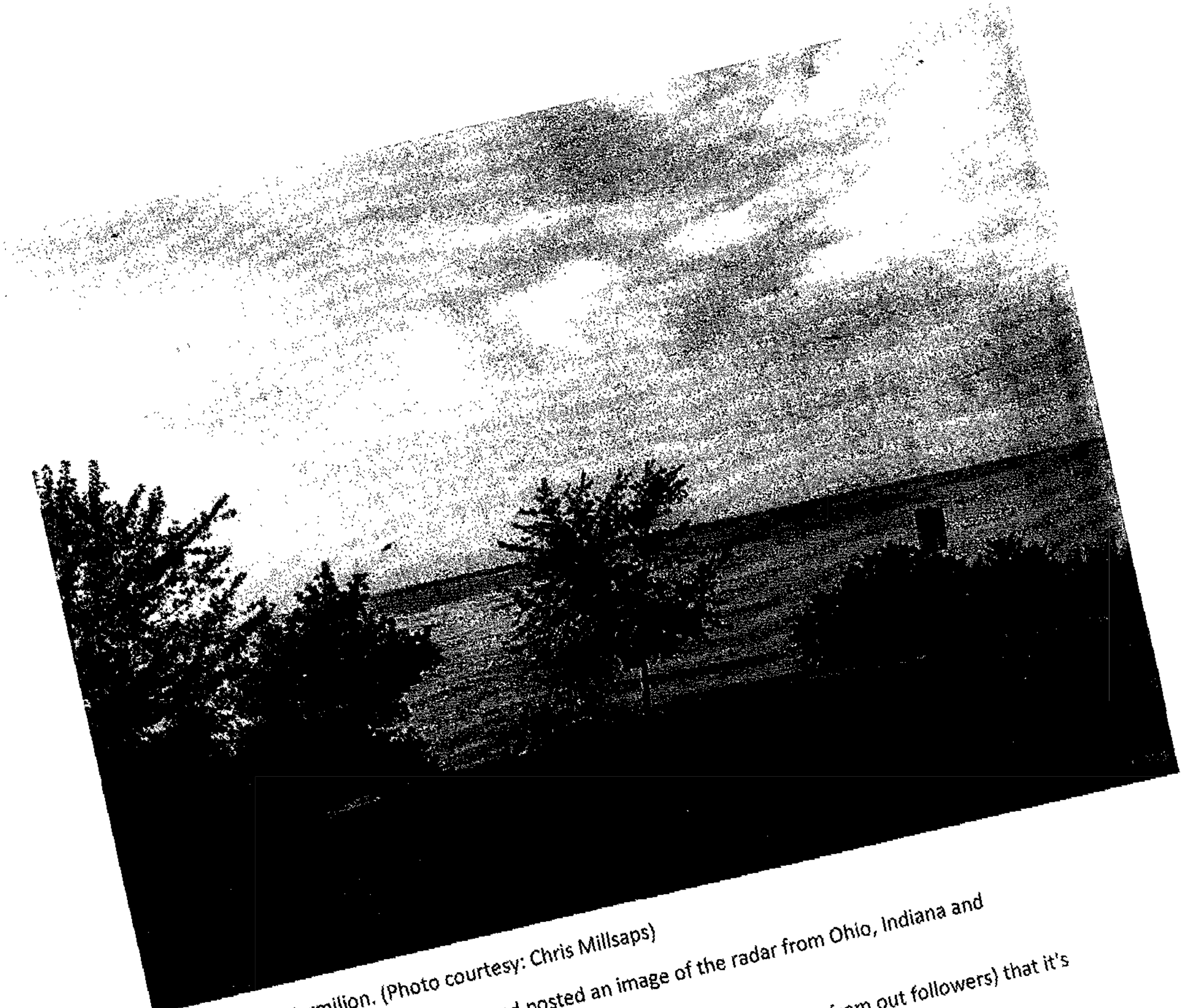
Dragonfly invasion (Video courtesy: Melanie Schaefer)

>

CLEVELAND-- Massive amounts of dragonflies were spotted over Ohio on Tuesday.

FOX 8 viewers reported seeing thousands of dragonflies in Lakewood, Lorain, Shelby, Vermilion and Willoughby.



Dragonflies in Vermilion. (Photo courtesy: Chris Millsaps)

The National Weather Service Cleveland posted an image of the radar from Ohio, Indiana and Pennsylvania, showing the insect invasion.

"While we are not biological experts, we have determined (through input from out followers) that it's most likely dragonflies mixed with other insects/birds," the NWS said on Twitter.

NWS Cleveland

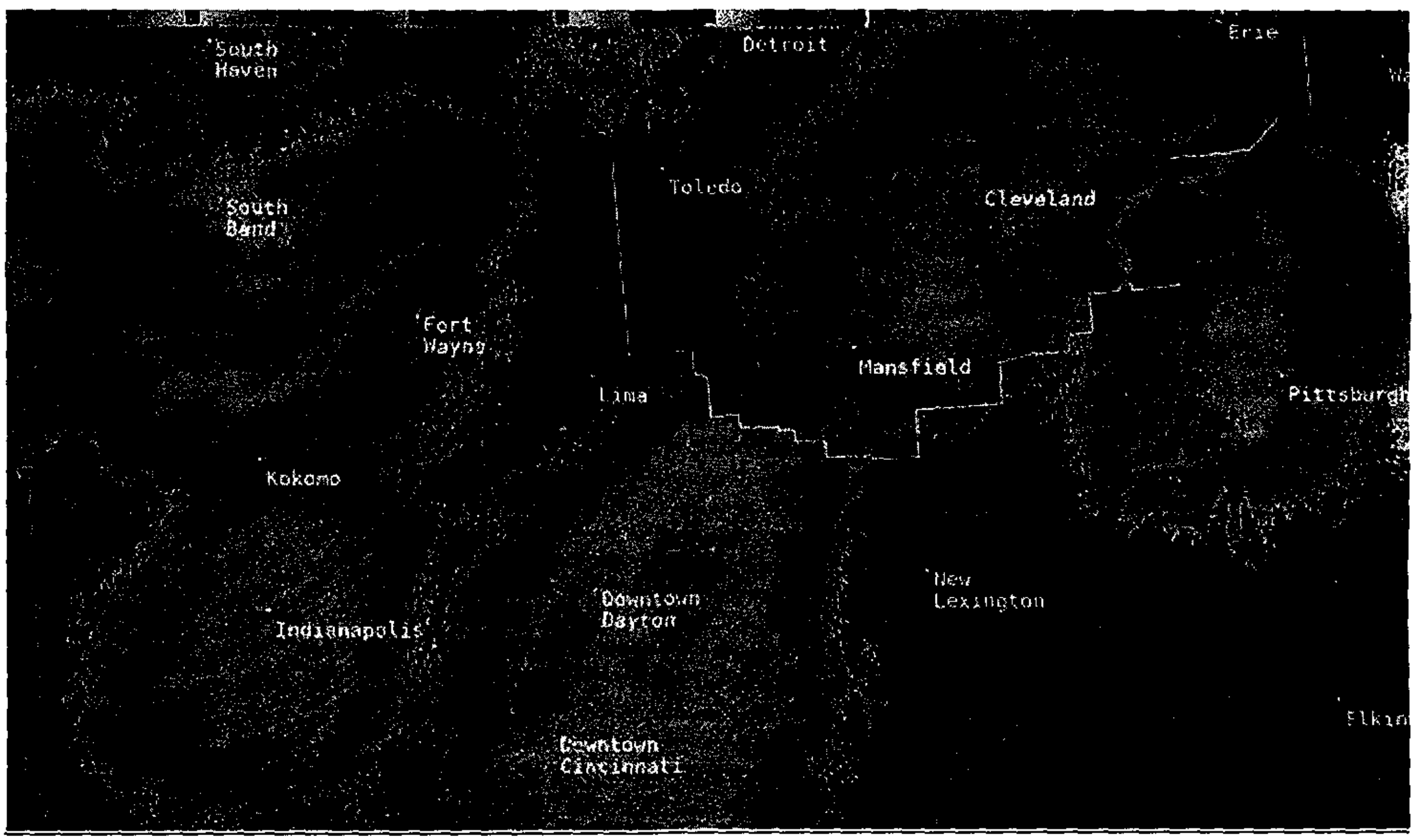
✓@NWSCLE

While we are not biological experts, we have determined (through input from our followers) that it's most likely dragonflies mixed with other insects/birds!
https://twitter.com/NWSCLE/status/1171553273322463232 ...

NWS Cleveland

✓@NWSCLE

This is not rain being observed by the radars across IN/OH/PA today. Care to take a guess as to what is traversing the region?



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7:10 PM - Sep 10, 2019

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