

**A Madison County, Iowa,  
Cardiologist's Investigation and Response to  
Industrial Wind Turbines in the Rural Residential Countryside  
Regarding Concerns of Adverse Health Effects  
And,  
Exploration of the Relevant Accompanying Larger Issues**

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# Table of Contents

<b>Page:</b>	<b>Content</b>
<b>1-10</b>	<b>Executive summary</b>
<b>11-13</b>	<b>Introductory Letter to Board of Zoning (Part 1)</b>
<b>14</b>	<b>Manual Design and Suggestions for Use</b>
<b>15-21</b>	<b>Part -2      Sleep</b>
15	Importance
16	I Have Seen the "Face" of Industrial wind Turbine (IWT) Harm
17	Disturbed Sleep - A Worsening Modern Health Epidemic Recent "Key" Medical Studies Linking Inadequate Sleep to Cardiovascular Events
18	A YouTube Documentary Worth Seeing
18	Disturbed Sleep from IWT Noise Emissions
20-21	Appendix:      2009 WHO Summary of Sleep Effects and Noise Thresholds
<b>22-28</b>	<b>Part - 3    Wind - Basics</b>
22	Sound Spectrum Defined by Frequency
23	Sound Measurement and Filtering
23	Shadow Flicker
24	Source of IWT Noise
24	Primer on Sound
25	Amplitude Modulation
26	Variable Noise Related to Blade Angle
26	Wind Turbine Noise is Distinctly Annoying
27	"Worst Case Conditions" Sound Propagation Models
28	Wind Speeds at Night: Contrary to Common Perception
<b>29-36</b>	<b>Part - 4    IWT Emission - Types</b>
29	Infrasound
29	Perception Thresholds, Serious Potential Consequences with Larger IWT Power Generating Capacity
30	Clear Lessons from N.D. Kelley Pioneering Studies
30	Infrasound Emission from IWTs Do Exist

31	Long-Range Propagation of Infrasound
33	IWT Separation and Infrasound
33	Sound Propagation and Computer Modeling
34	Low Frequency Sound
35	Annoyance
36	Appendix: (textbook) Inner and Outer Hair Cell Responses, Hearing Thresholds
in	Infrasound and Lower-Frequency Sound Spectrum
<b>37-50</b>	<b>Part- 5 History</b>
37	Wind Energy's Wind Ordinance Preference: Derived for Profit Where Did It come From and Will It Protect Human Health?
37	Early ILFN Recognition from Turbines and HVAC Systems - Striking Similarity With Industrial Wind Turbine Emissions and Symptoms
39	Hearing vs. Perceiving - Both can Produce AHEs
41	Wind Energy Concedes "Annoyance" Exists, but Offers Other Excuses
42	NASA and DOE Funded Research: First (and Lasting) Confirmation of IWT Emissions and Associated Health Effects - Now Denied by Wind Energy
44	1500-foot Setback Recommendation by MAE and its Historical Origen
45	ETSU-R-97
48	Pathway to Subsequent Adoption Worldwide
49	Where is U.S. Federal-level Oversight?
<b>51-78</b>	<b>Part - 6 Adverse Health Effects</b>
51	Bob Thorne, PhD: IWT Study (2012) and Textbook (2014)
61	Annoyance
63	Low-Frequency Sound
64	Infrasound Recognition and AHEs
65	Perception of Infrasound by a Deaf Woman
65	Infrasound Perception from Wind Turbines and the Inner Ear - Dr. Salt
66	Measuring Infrasound
67	IWT Noise and The Development of Cardiovascular Disease
68	What is Going On: Deep Dive into a Much Deeper Pond
70	Obstructive Sleep Apnea - a Model to Consider for IWT Effects
71	World Health Organization Comments

73	Appendix: Home Vacating Article – Carmen Krogh
74	Health Canada Study - Annoyance related to Turbine Noise
75	Textbook: Wind Farm Noise (cover and author list)
76	Annoyance of IWT Noise vs Other Environmental Sources
77-78	Wind Turbine Signature (Infrasound) - 2 examples
<b>79-95</b>	<b>Part - 7 Other Select Topics</b>
79	Nocebo Effect
81	Sound Perception
81	Human Rights and Social Justice
83	Vulnerable Populations
84	Potential Concerns of IWTs in Proximity to Schools
86	Increased Cardiovascular Disease Associated with Life in Rural Areas
87	Recent U.S. Upward Trending Death Rates from Hypertension
87	Electricity Costs
89	Decommissioning Implications
90	Litigation: A replacement of Science and Failure of Leadership
92	SCADA and NRO
93	Blade Throw: We Need to Have Written, Model-Specific Safety Information
95	Appendix: European Electricity Prices vs Extent of Installed "Renewable" Energy Sources
<b>96-100</b>	<b>Part - 8 Peer Review</b>
96	IRB Process: Gold Standard Evaluation of Safety that has Never Been Done
97	Causality – Professor A.B. Hill
100-102	ACWEA Report
<b>103-122</b>	<b>Part - 9 Searching for an Explanation of Why Harm is Acceptable... A View Toward the "Dark Side"</b>
103	Wind Energy/Vestas - Behind the Scenes
103	Attack on a Science Leader Who Told the Truth
103	Wind Energy Self-Protecting Ordinance Writing
104	Declaring "Fact" Through Misuse of Standard Acoustical Instruments
108-109	Appendix: 2005 BWEA and 2020 AWEA IWT Health Claims
110	Danish Physician (Mauri Johansson) Addresses Vestas "Central": A Profile of

	Courage
111-120	Vestas' Response to Australian Regulation Attempts to Control Noise
121-122	Vestas Protest of Increased Noise Control of Low-frequency noise
<b>122-126</b>	<b>Part - 10 Carbon Management</b>
122	We agree on Some Things
122	Planet of the Humans
122	Hard Realities that are Catching Up and Now Demand Action
123	Renewable Options without IWT Risks
124	An Extraordinary Opportunity for Iowa
125-126	Appendix: National Geographic Projection of Electrical Generation by 2050
<b>127-134</b>	<b>Part - 11 Applied Regulation of Noise</b>
127	Relevance of Background Noise
128	Lmax vs Leq - Relating to an Open or Closed Window
128	(Audible) dBA Calculations (as a Function of distance) for the V-110 IWT
130	Outside to Inside Noise Reduction
130	Windows - Open or Closed?
132	Relationship Between Night Noise and Health Effects
133-134	Loudness Variation over the Sound Spectrum
<b>135-138</b>	<b>Part - 12 Ordinance Examples and Regulation</b>
135	Setbacks
135	Siting Turbines: Considerations
136	Setback Proposals
137	Additional Published Sound Limits
<b>139-146</b>	<b>Part - 13 Recommendations</b>
139	Lmax
139	Site Retooling
140	Need to Have Wind Ordinance specify ANSI Standards
141-146	Wind Farm Noise (Textbook) Wind Ordinance Recommendations
<b>147-169</b>	<b>Part - 14 Expedited "Part" Summaries</b>
<b>170-179</b>	<b>Part - 15 Conclusions, Appendix: Mathias Basner</b>

## **Executive Summary**

While ongoing for decades, more recently recorded consecutive years of rising oceans and mean global temperatures with increasing patterns of intensifying storms and fires have only heightened Man's resolve to fundamentally change worldwide dependence on fossil fuels. We are now responding with a sense of urgency. "Renewable" energies, particularly wind and solar, among other renewable sources, have been promoted as "winning solutions". Photovoltaic (solar) energy has become more affordable and is utilized more in sunnier locales. Commercially, beginning in northern Europe, Industrial wind turbines have, over three decades, spread rapidly across the globe. With increases in size to achieve increased power generation capacity, they appeared in the U.S. initially as a novelty but have been rapidly proliferated without a "proper introduction". Seemingly simple and intuitively harmless in design and implementation, when placed too close to human habitation, serious problems have occurred. It is as though we "leaped before we looked".

**I am a Cardiologist who specialized in heart rhythm problems and I am providing a personal statement primarily focused on the adverse health effects (AHEs) arising from industrial wind turbines (IWTs).**

### **A bit of history ties my interest to this concern:**

Over two years ago, the "legitimacy" of industrial wind turbines as a source of SAFE and sustainable electricity was suddenly thrust into my life. This appeared as a "benign letter" from a local energy provider. Proposed, was a 52-turbine farm to be erected close to my property... a place protected by a conservation easement for having a few remnant prairie hillsides. In the surrounding miles, grazing and row-crop agriculture was the focused livelihood. These communities are the definition of an extremely quiet "rural residential" landscape. I knew almost nothing about wind turbines and, like nearly everyone, thought they were quiet, good for the world and assumed they were safe. In the ensuing weeks, public meetings were held where interested citizens had a chance to voice their opinions and concerns. Despite very time-limited presentations, it became obvious that opinions had rapidly polarized, shifting the debate from county vs an outside faceless large corporation to neighbor vs neighbor. Mid-American Energy (MAE), the Wind contractor, was there to answer questions but provided no hand-outs nor substantial didactic information. They sat in a group being largely silent, they only returned brief, limited answers when questioned. There was an industry physician-consultant from Boston who presented his opinions but no facts or data, and directly dismissed that noise related complaints were "real". Instead, (he implied) that those complaints were mostly imaginary physical or mental consequences from the presence of the IWTs. Any reasonable person present walked away after the meetings having no idea what health ramifications from IWTs might occur. The word "obfuscation" (the action of making something obscure, unclear or unintelligible) appeared in my mind.

### **Wind Energy's Position about Adverse Health Effects:**

In these initial Board of Adjustment, and then later Board of Health meetings, **Wind Energy maintained their "position":**

1) **that** Industrial Wind Turbines are safe - yet without qualifications of how that self-designation of "SAFE" was given" – no studies, records and evaluations of structure failures, etc. They almost always follow the "safe statement" with boasting of the number of IWTs they have placed in Iowa and the revenue to the state, jobs created, and on and on, but never have provided evidence that scientifically proves "they are safe". Wind energy has limited "original" investigative research. Often a panel judges whether existing data supports the assertions by scientists that IWTs do cause AHEs. The subsequent peer review become akin to judging "opinions with opinions". Importantly, "indirect" impacts, which Wind Energy routinely ignores, are just as significant to the people who are impacted as are "direct" impacts. In fact, there is an enormous amount of data linking IWTs noise emissions to direct and indirect AHEs. Thorough and objective reviews of Wind energy's claims have been challenged and previously "debunked" (Punch and James, 2016). When challenging Wind Energy's representatives with the assertion that "industrial wind turbines have never been proven or shown to

be safe", the don't respond – almost as a "taught response". Yet, after a Board of Health meeting, even one of the "pro-wind" Iowa Environmental Council academic speakers did agree with me that IWTs have **not** been proven to be safe.

2) **that** they (MAE) receive very few complaints... eventually they resolve. They contend that the "nocebo effect" accounts for most resident complaints. In this context, the nocebo effect is the association of symptoms and complaints "brought-on" by existing negative attitudes toward IWTs.

3) **that** there is no credible evidence that IWTs cause cardiovascular disease or metabolic disease.

4) **that** they reluctantly admit that some of "their studies" show that IWTs cause "annoyance" but reflect that it has no substantial health impact. Wind Energy, never comments about IWT-associated "severe annoyance" that causes resident evacuations of their home (which is also considered an adverse health effect).

5) **that** they will not admit that IWT noise causes sleep disruption. Strongly connected to this is their assertion that infrasound and low-frequency noise (ILFN) as a product of IWTs, accounts for a small part of the IWT noise and that infrasound cannot be heard and therefore cannot cause harm. Indeed, they firmly contend that ILFN is of no concern and strongly insist it should not be regulated.

I have carefully reviewed Wind Energy's position on all these adverse health effects. I have searched for definitions, textbooks, articles, and the presence and quality of reported peer-review. When defending their assertion that IWTs are safe, Wind Energy speaks both slowly, and definitively then "hides" behind the spoken words "no credible evidence". A reasonable person would ask "What would Wind Energy consider as credible evidence" and, as a concerned resident, what "credible evidence" have you produced that proves that IWTs are safe?

### **Purpose of this Manual**

In this manual, I have collected information – first for myself - to clarify and resolve my questions and concerns. As the answers became evident (though admittedly difficult to find, clarify and integrate), the story of how this "intrusion" happened became clear and I share it with you. This manual will hopefully later serve as a resource for all who will question what health risks (as known in 2020) may be associated with living close to industrial wind turbines. This information took several years to collect. The process by which Wind Industry acquires county permitting is "rushed through" in literally only several weeks making this information, given that inconsiderate timeline, virtually unobtainable.

In this manual, I present evidence supporting my opinion that Industrial Wind Turbines (IWTs) will cause adverse health effects when located near residential properties in formerly quiet rural residential communities. Beyond the potential serious health implications... we all need to fully understand and reflect carefully on the full implication of what these behemoth oscillating blades mounted high on towers will do to our personal and social and environmental communities.

I present relevant aspects of IWT-generated noise - including noise classification and its quantitative labeling through frequency and decibels measures and types of weighting through various filter types and how accurate noise exposure quantification is affected by filtering choices. The unique characteristics of IWT noise are reviewed and compared with other environmental noises. I will review the categories of noise frequencies across the entire range of emission of IWTs and important aspects of noise propagation and attenuation. Please view the table of contents for contained subjects; ALL of these subjects are relevant. The reader **must NOT stop** at the simple debate of "he said vs she said" about health impacts. I found the answers largely in what "wasn't said" and past "acoustical history" and current corporate behavior.

I will highlight important historical events that add to the context of today's IWT regulation. For example, we need to be fully aware that VERY in-depth evaluations were done in the mid-1980s by NASA and the Dept of Energy-funded research. Scientists (N.D. Kelley, et. al.), in their thorough (basic science-level) investigations, were asked to evaluate the potential possible implementation of IWTs for adverse impacts. Their focus was on

understanding the physics of wind turbine operation and energy production. They also studied noise types produced by IWTs and observed and reported on the first confirmed cases of adverse health effects that developed with IWT prototypes up to 4 MW in generating capacity. Their initial determinations of ILFN and associated serious AHEs were first raised then and remain relevant to this day, although ignored by Wind Energy and its proponents. Also revealing is the history of acoustical evaluation of health-impacted occupants of some newly erected buildings from the 1970s to 1990s that was characterized as “sick-building syndrome”. Recognized in affected subjects, were similar symptoms connected to working near gas-fired turbines. Careful evaluations confirmed that ILFN from indoor HVAC (heating/cooling units) produced the symptoms. Fortunately, buildings can be re-designed, defects in air ducts fixed, and additional sound insulation placed, but the only way to eliminate ILFN from IWTs is to turn them off or distance them from residents and their property far enough away that the ILFN can no longer be heard nor “perceived”.

**There are other issues besides adverse health effects:**

It is important to ask questions and demand that they be answered; DO NOT assume that what Wind Energy is telling you is correct. Questions, such as “where did these setbacks come from? How, based on what we know, can we have setback distances that are so close and still be considered ‘safe’? Whose responsibility is it to review these setbacks and decide if they are safe? How did Wind Energy’s proclamation that ILFN ‘is not a health concern’ ever become “accepted?” Why is potentially harmful noise pollution allowed to trespass across the private land of non-participating neighbors – particularly when pollution regulation for other industries occurs up to/at the property line?” I still ask whether the MAE’s land easements (for the entire host property) and the value of that land is used as collateral for the financing of the purchase and erection of the wind farms? If it is, what happens to that land ownership in the event that America comes to: 1) reject the denial of Wind Energy’s adverse health consequences, **and also** 2) see that Wind Energy is not “green” and requires concomitant availability of back-up natural gas-burning that essentially negates any “renewable” aspects **and** 3) realize that the real cost of that electricity is roughly 3 times the cost of conventional electric power/kw of energy produced once the subsidies are factored out. Shouldn’t we be building energy power plants that work nearly all the time (instead only one-third) and have a productive life of at least 40-50 years **and** 4) understand the extraordinary expense not only to maintain a functioning turbine but also related to eventual turbine/site decommissioning and non-recyclable blade disposal costs.

Where does all that money come from? Fifty-eight-year leases are a long time – generations come and go, political party majorities and Presidential decrees that control the narratives keep flipping and MUCH better power production sources will become available. We need to think more about this before “leaping further.”

I include in “Part 9” important findings while searching for an explanation of why inflicting harm on people living in host communities is “acceptable”. To understand why things don’t make sense you often have to explore the motives of – (in this case, including, but not limited to) Wind Energy. Beyond the motives, are the real actions and developed agendas that allow an industry to secure, maintain and perpetuate “their narrative.” I have included several examples of what some would call “blatant” deception. For example, there is a formal presentation made by a Danish healthcare practitioner (Dr. Johansson) to Vestas’ executives where “the truth was told” but his warnings were ignored. I will leave the reader to draw his own conclusions. Sadly, the whole process continues largely unchanged. Wind Energy apparently deems their current approach as a successful business plan and continues their practices largely unchanged. We, as the users who consume electricity, have a right to know the truth behind the industry’s talking points.

It would be unfair to criticize wind energy production as an answer to global warming without offering other solutions. That said, one might assume that if an obvious better choice was available without all the problems and negative health impacts as I have reviewed, it would’ve been pursued. However, there are alternatives that are ignored. My comments are listed in part 10, “Carbon Management”.

**Stay Focused on the “Broad” Definition of Health**



When the public or politicians are asked if wind turbines are dangerous or cause health problems, they sometimes “mentally imagine” the worst – post-apocalyptic or post-wartime images or even human suffering with death and hospitalization of the order we now see with the Covid-19 pandemic. Even “captured” politicians, proponents, and/or Wind Energy trade organizations couldn’t sell that when subjected to any scientific scrutiny. Instead, we need to remain “broad-minded” to what health actually is - which is NOT limited to a defined set of continuously disabling symptoms that evolve in everyone over the short term and likely affects everyone the same. It is also not limited to a health effect that is progressive until death develops or when eventual disease syndromes become established with an established diagnosis. Adverse health consequences of environmental noise can be the asymptomatic (unrecognized) development of hypertension or vascular atherosclerosis or insulin resistance or can be much simply defined as the “the loss of wellbeing”. Indeed, some of the most common and impactful adverse health effects may come “as” headaches, tinnitus, dizziness, subtle confusion, unexplained loss of ambition or productivity, emotional lability or obvious or subtle depressive symptoms. Noise adverse health effects may initiate and accelerate disease progression, that **may**, when combined with genetic or known “accelerators” of disease (smoking, alcohol abuse, etc.) over a life-time, manifest as a recognized cardiovascular disease event – stroke, fatal or non-fatal heart attacks.

The World Health Organization (WHO) defines “health” as a state of complete physical, mental and social wellbeing... The WHO definition links health explicitly with wellbeing and conceptualizes health as a human right requiring physical and social resources to achieve and maintain. Mental and physical health are inextricably connected, thus highlighting that “annoyance” – at almost any level – can contribute to adverse health effects (AHEs). As described by DeFrock (Australian), “Annoyance is a non-quantitative word that implies mildness in common use. A more accurate general descriptor would be mild, serious or ‘intolerable’ impacts.” In the context of this report, “annoyance” generally means “High Annoyance” where it can result in indirect adverse health impacts. But even “mild” annoyance can create a negative or disagreeable reaction (which is NOT the nocebo effect) that can create a loss of wellbeing. Wellbeing refers to a positive rather than neutral state, framing health as a positive aspiration. Wellbeing is defined as “the state of being comfortable, healthy or happy”. Shouldn’t we protect an individual right to health and happiness – that defines wellbeing - by limiting intrusive noise pollution at one’s private property line?

### **Cardiovascular Disease Explained (simplified)**

In the Cardiology world, “atherosclerosis” is a term describing the development of (lipid (fats)-filled plaques) that get sequestered within the superficial inner layer of arteries that is contained by a “thin fibrous cap”. These are initiated and develop through a complex process simply characterized as “inflammation”. Standard cardiac “risk factors, e.g. smoking, diabetes and others) facilitate atherosclerosis development. As plaque evolves, there is a complex action via cellular and neurohumoral processes that appear to be quite similar to those seen originating from other triggering sources. Some of those sources include small-sized air pollution particulates, PTSD, and of particular importance, environmental noise. In my medical practice I treat atrial fibrillation. Nearly half of those patients also have obstructive sleep apnea (OSA) which is thought to have significant adverse inflammatory triggering that may promote concomitant ischemic heart disease, hypertension and insulin resistance. Although likely less intense as a “stressor” than OSA, I believe IWTs act similarly through a stress related inflammatory pathway to promote cardiovascular disease.

With noise as the trigger, it is thought cardiovascular disease is promoted from “from an increased physiologic stress response” from noise levels “in excess of defined intensities”. It appears there are noise thresholds (which the WHO has attempted to define). Similar to OSA, it may also occur indirectly through noise-associated sleep disturbance which then produces a “stress response” via the sympathetic limb (“fight or flight”) of the autonomic nervous system. The autonomic nervous system can trigger vessel inflammation which then can promote atherosclerosis. In general, the more and longer the stress continues, the older the individual (with more time to develop larger and more “unstable” plaques), the more the likelihood that disease will become evident or “expressed”. With often unpredictable sudden “stress response triggers and/or anatomical plaque instability,” the plaque ruptures, exposing the lipid-rich core that initiates “local clotting” that may enlarge and

propagate causing potential artery closure that quickly produces a state of deprived “down-stream” oxygen delivery. In the heart, when this happens, it causes a heart attack – termed “myocardial infarction”. Health means living a life where such consequences become less likely through avoiding or mitigating “unconscious inflammatory bodily responses” that promote the genesis of disease states. Atherosclerosis development should never, minimally, suddenly or eventually be allowed to continue so as to produce cardiovascular disease “endpoints”.

#### **World Health Organization Comments on Wind Turbines (2018 Report)**

Acceptable environmental noise exposure levels are defined in the Oct. 2018 WHO report for aircraft, rail, general industry, and road traffic sources, with “strong recommendations”. That rating reflects the quality and the amount of the scientific data relevant to those studied noise sources. Also, in that publication - for the first time - a suggested “conditional” exposure level for wind turbine noise exposure being expressed as “Lden” was published. Lden means average sound Level: day, evening, and night of AUDIBLE noise as “averaged” over a 24-hour period with penalties of 5 dBA for evening periods, and 10 dBA for nighttime periods. It is measured using a sound meter set to use the “dBA” filter and weighted by time of day for the penalties. That filter is the most common one promoted by Wind Energy in turbine acoustics and is “centered” around 1000 hertz. The problem with this is that it does not accurately reflect the acoustic energy of ILFN. The conditional wind turbine noise level exposure was a limit of 45 dBA Lden, equal to that of aircraft noise but substantially lower (more restrictive) than railway or road traffic. Assuming wind turbines operate 24 hours a day this limit is equivalent to a 38 dBA Leq 24-hour average sound level. The data review committee of the WHO document recommended “policymakers implement suitable measures to reduce exposure from wind turbines in that population exposure to levels above the guideline values”. The “conditional” recommendation reflected that the data was not “robust enough (statistically, due to small numbers of subjects)” to support a “strong” recommendation. Importantly, they commented that there was no data suggesting that there was no risk. It is worth noting that the WHO’s 38 dBA Leq 24 hour average is what would be calculated using the American National Standards Institute (ANSI) and Acoustical Society of America (ASA) Standard S12.9 Part 4 for assessing Land Use Compatibility. It is important to consider that the pre-specified health outcome evidence used was mostly limited to more serious adverse health consequences such as ischemic heart disease (atherosclerotic-disease related), hypertension (elevated sympathetic tone and acquired loss of normal vessel relaxation related) as well as the prevalence of highly-annoyed populations (outdoors). Because wind turbine sound fluctuates as much as 11 dBA above the average this level would not eliminate stress from moderate annoyance or sleep disturbance.

I have also included “noise response curves” for severe annoyance in the appendix of part 6 (Adverse Health Effects) from the Wind Farm Noise Textbook (Hansen, Doolan, Hansen, 2017) that show published data (2001, 2008, 2016) from several studies. These two graphs IMPORTANTLY reflect an even greater annoyance from IWTs (which is dominated by low frequency noise) than what is reflected by dBA measurements (measuring only audible noise) as was used in the WHO report. This highlights that IWT noise is commonly described as “distinctly annoying” and is composed of noise from nearly all portions of the noise spectrum, rumble, roar and whoosh type sound. Indeed, the omnipresent component of ILFN is a real and prominent contributor to increased annoyance from IWT noise. IWT noise can be even heard when below background noises like leaf rustle, comprised of mainly mid and high frequency sound in communities at night likely due our perception of that low frequency noise component. Annoyance derived across the “wide-range” of frequency components of IWT noise NEEDS be accounted for when enacting “protective wind ordinances.”

It is remarkable (to my knowledge) that Wind Energy has not commented on these incredibly high-level scientific assessments of potential concerns of environmental noise. The WHO virtually echoes that IWTs have never been shown to be safe. The WHO also clearly moves **toward** the level of declaration I make in this manual: that IWTs have AHEs including possibly serious cardiovascular effects. In fact, **there is strong credible evidence** that IWTs produce serious AHEs

I would suggest separate regulatory noise limits for both audible and ILFN noise exposures with both 40 dBA (for audible) and 60 dBC (for ILFN) noise limits – each expressed as “shall-not-exceed” dBA or dBC ( $L_{\max(\text{fast})}$ ). Compliance with these limits shall be measured by Class 1 sound level meters set to use the “fast” measurement circuits. Other circuits incorporate averaging which will understate the fluctuating character of wind turbines that is the likely cause of annoyance, sleep disturbance, and other AHEs. Despite that MAE would like to suggest otherwise, dBC measuring tools are “standard” on professional grade sound measuring equipment which can measure both at the same time. Noise levels can be easily obtained at the property line. Prior regulatory parameters of setback distances (e.g. 1500 feet) or 45 to 50 dBA as Leq averaged sound levels) will NOT be protective of human adverse health effects. They do NOT account for fluctuating audible and ILFN acoustic energy – that have been correlated to AHEs, or the location of non-participating residences on their properties. When any wind contractor sites a turbine, they should include a design safety factor to be certain that during periods of fluctuating sound emissions the project will not exceed either of those noise limits or it will be “out of compliance”. If they are uncertain about audible and ILFN propagation/attenuation or the accuracy of computer modeling, then a greater distance-separation or use of a quieter wind turbine make and model should be used so as to completely eliminate the potential of harming residents”. Sound limits are carefully defined to protect residents and should not reflect a compromise to facilitate industrial development. Non-compliance or less restrictive noise limits that result in resident harm is NOT acceptable as reasonable “collateral damage”. Of note, George Hessler published a 2004 article that proposed dBC criteria in residential communities for low-frequency noise emissions from industrial sources that do not have fluctuating sound as a primary characteristic.

#### **What are the Noises that IWT make?**

IWT noise includes regular, dominant “pulsing” sensations perceived as either audible fluctuations in the sound or as bodily “pressures” due to air compression of the flowing air mass. These pressure waves are caused by changes in the lift of each of the 3 blades as they pass in front of the huge supporting tower. Also, as the blades rotate through the frequently vertically-stratified moving air mass, they may, under heavy “loading” conditions, lose lift (or stall) producing perceptible rhythmic swishing/thumping sound to which residents can become sensitized. Residents can often perceive these fluctuations as “whooshes” or “thumps” at considerable distances, well over a half mile - which is quite disagreeable and difficult to block from one’s awareness and may occur at a distance where the IWT cannot yet be seen, especially during the night when people are sleeping in quiet bedrooms. There is a rhythmic pulsation generated at the trailing-edge blade noise by the steady rotation speed that produces “blade-swish whooshes and thumps” and irregular, low-frequency “roar” from the blades due to in-flow turbulence. Collectively, there is a continuum of frequencies stretching from pressure pulsations at infrasonic frequencies 0.5 Hz (cycles per second) up through the normal hearing range of 1000 to 2000 Hz that are generated by each turbine. The sound immissions from each wind turbine also interact with nearby turbines to produce a constantly changing and distracting medley of fluctuating sound-called amplitude modulation. Depending on the frequency amplitude modulation of IWTs, ILFN is both heard and perceived and easily evokes mental and physical stress. Unlike “less complex” daily noises, IWT noise does not become “accepted” by our perception processes and then unconsciously ignored. The subtle but constant changes make it difficult to impossible to ignore. Further, residential construction of residential homes for sound insulation does not effectively block the lower frequency noises. Further, people have a right to sleep with open windows which effectively eliminate any protection offered by walls and roofs. Trying to mask IWT noise by producing bland artificial “background” noise inside a home can only mitigate some portions - but not all of “stress-creating” wind turbine noise. As coping residents engage in their daily tasks, while the turbines operate above, only a momentary lapse of that focus will remind them of the enveloping dome that separates them from the peaceful world they once enjoyed.

#### **Included Important Historical Insights into Wind Energy Claims**

I have included in Part #9 a number of related events, letters and a copy of a speech that unveil what Wind Energy (Vestas – largest worldwide producer of IWTs) has done to advance their “narrative” centered around the promotion of IWTs.

When the state of New South Wales (NSW) in southeastern Australia approached Vestas about implementing IWT power, the state government presented to Vestas an initial draft of guidelines that contained low frequency noise regulation that outlined that state’s proposed future “recognition, acceptance and treatment” of ILFN. In the beginning of that March, 2012 letter, Vestas in their “Executive Summary” response letter, immediately made clear their opinions about careful, science-based, health-protective regulations that would govern implementation of a new energy technology in NSW. They bluntly summarized: *“Vestas opposes the Draft Guidelines, primarily because of the sheer number of additional requirements and barriers that would be placed in front of the wind energy industry without any clear evidence, justification or demonstrated need for this additional regulation”*. By that time (2012), there had been several years of rigorous publications by scientific investigators and acousticians as well as likely thousands of reports of adverse effects including forced home evacuations. In general, NSW concerns were raised that mostly involved human health – in all forms. These included setbacks (proposed at 2 km), visual amenity, noise, health, decommissioning, auditing and compliance, environmental impact statements, property values, blade throw, conditions of consent and compliance as well as others. Vestas’ extraordinarily self-serving retorts to each of these concerns were “abrupt and terse” (and without basis) – other than they are viewed as too restrictive to advance IWT introduction – which they admit was **the** primary issue. Comments about noise from NSW in the draft were recommended to *“be deleted in their entirety”* so as *“not to give the impression that the NSW Government places any credibility in the false claims of the anti-wind activist groups on the topic of health impacts”*. Decommissioning concerns were raised by NSW. Vestas did support a decommissioning and rehabilitation plan in the **environmental assessment** report, however, did not support the requirement to provide a decommissioning bond, nor have periodic updates in anticipated costs and implied that wind farm operators would maintain their assets for as long as possible since wind is “free.” Vestas did not support the adoption of the noise guidelines as they claimed they were: unnecessary, discriminatory, and unclear. Again, the word “obfuscation” comes to mind. It should remain absolutely clear to any entity regulating IWTs into their jurisdiction that all these topics (and more) raised here ARE relevant and need to be addressed in writing in any Wind Ordinance; if it is not clarified, then compliance cannot be enforced.

#### **ILFN: Convenient Flip-Flopping by Wind Energy for their Agendas**

Further, to have health protective IWT noise regulation, as noted many times, recognition and regulation of ILFN is “critical”. It is also my opinion when reviewing several “lines of historical action and commentary by Wind Energy” that Wind Energy recognized (certainly no later than the mid-1990s) the “threat” of ILFN to their business. As mentioned earlier, N.D. Kelley clearly identified the existence and the health threat from ILFN in the mid-1980s. In the same letter (above) and then in another one just a year before, Vestas reveals that they knew “true implications of ILFN and its health concerns”. In the response to NSW suggested guidelines, Vestas denied that ILFN was a cause of AHEs and proclaimed: 1) it is therefore unnecessary to require the prediction and monitoring of low frequency noise emission from wind turbines, 2) the existing and well- validated industry standard models for acoustic propagation are not designed to deal with frequencies at the low end of the audible spectrum, specifically because noise emissions in this band are not considered to pose issues likely to affect the surrounding environment, 3) “accordingly” Vestas suggests the removal of the requirements to measure low frequency noise from the Draft Guidelines. Yet, less than a year **earlier**, Vestas AU had written a letter to the Danish EPA claiming that a new low frequency noise limit for wind turbines could not be met because there were no design changes to modern utility scale wind turbines that could further reduce wind turbine noise to meet the new low frequency limits. On the one hand they claim there is no problem, and on

the other hand they claim that there is no solution to a problem that they admit is a characteristic of wind turbines. (My comment: There is something rotten in Denmark). It is clear to me that Vestas recognized that ILFN would be a defining concern for IWTs – particularly as power generating capacity increased (which Vestas was rapidly designing and implementing for future designs). The newer larger MW models use longer the blades and slower hub rpm. This results in more ILFN than for earlier lower MW models with shorter blades and faster rotation speeds. The Wind Industry has adopted Vestas' stance about ILFN importance. We, as the potential residents to be affected and possibly suffer harm, need to clarify for ourselves the true existence of and potential harm from ILFN and react responsibly by regulating these harmful emissions generated by IWTs – especially with increasingly larger models that are more often being “clumped” together.

**The Need for Informed Consent when KNOWN Unknown-Risks Exist.**

The proposed affected residents, by a super-majority, opposes the plan (for Arbor Hills Wind Facility, Madison County) based on concerns of adverse health risks. At the same time, only a small-minority of easement owners (22%) actually live on the property and would have to endure the same health consequences. Reportedly they are not allowed, by contract, to raise health-related concerns that might arise while residing at the property. How this affects people living on that property to farm the land is not known. Having spoken to residents about their “signing experience” with a wind industry, they didn't recall that the representative declared the turbines “safe”. They did, however, clearly remember that there was no listing or mentioning of possible adverse events, reports of serious or mild annoyance nor potential longer-term cardiovascular consequences. This failure to disclose potential risks to the participating landowner OR the non-participating (but still noise-affected neighboring resident) is bothersome and reflects a lack of due-diligence, oversight, and protective jurisprudence. With decades of ongoing concern and innumerable science-supported reports of occurring harm and well-researched plausible serious adverse health effects being published, one could reasonably describe the omission of informed consent as a failure of duty of the party seeking the easement to properly notify the lease of known risks. (Writer comment: While I not an attorney, very similar scenarios occur in human research where volunteers are asked to participate in a “condition” where there are unknown (or let alone known) potential health risks in return for financial compensation. To a reasonable person, such easement contracts demand greater transparency and much higher levels of subject protection. While it is true that Wind Industry contractors are not involved in a “medical study” per se, they are entering into a contract with potential known and unknown health consequences for which a consideration of payment is given in exchange for accepting the potential harmful consequences of exposure to that added risk, (IWT noise emissions).

**This “Manual” is to Promote a Clearer and Accurate Description of Industrial Wind Turbines**

I have written this personal statement for myself to collect, consider and organize the mass of information and misinformation present on IWTs. I personally have known the feelings of surprise, bewilderment, confusion, and hopeless frustration upon learning that a large industrial complex could be permitted into quiet rural residential locales that is zoned for agriculture. At county meetings where citizens voiced their concerns “on both sides” of the argument, there were some that mentioned it was their “right” to be able to earn income from the leasing of their property. Of those relatively few, there was no one that I can recall that said that it was acceptable that wind turbines could then produce noise that would actually harm their neighbors. None mentioned that their neighbors also have a “right” to enjoy the peaceful use of their properties. The authors of a comprehensive textbook “Wind Farm Noise” distilled all the conflicting pro- or anti-wind rhetoric in a simple declaration: **“it is time to stop debating whether or not a problem exists. It is well known that wind farm noise does result in sleep disturbance and health effects for some people and the time has come to decide what to do about it. The fact remains that some people are so affected by wind farm noise that their health suffers and some are forced to leave their home in order to achieve an acceptable quality of life.”** We need to

respect each other and look for energy solutions that make sense and most residents agree about. I have desperately sought for the truth as minimal information or, (upon fact-checking), frequently incorrect information was given by a power company who planned to produce a “secure profit”. I hope this “true” version of truth is useful to those who need to make important decisions, protect themselves and their property and assist for clarification of concepts regarding Industrial wind turbine implementation and regulation. When finally understood in “all in its convoluted and conflicting enormity”, it will hopefully be clear where the real questions remain.

**Points to Remember:** Returning to my initial assumptions upon hearing that IWTs might be placed closely to my property, I mentioned that “I thought they were quiet, good for the world and assumed they were safe”. Exploring much further, I now know that NONE of those are true. IWTs make a lot of distressing noise, when examined as a “possible solution for climate change” they don’t make sense given cost, limited life, intermittency, dependence on CO2-producing energy back-up and affordable and adequate battery technology is possibly “beyond reach” and, they are clearly NOT safe for myriad number of reasons which I tried to describe in detail. IWTs cause adverse health effects with that definition being consistent with WHO definitions and currently practiced health care. We are now in an era in science where we know that environmental factors – particular noise – can and does cause adverse health effects which can include serious cardiovascular consequences. Advances in understanding the consequences of disturbed sleep raise concern for contributing to the development of Alzheimer’s disease. Shortened sleep duration has been highly correlated with cardiovascular disease development and endpoints of hypertension and ischemic heart disease.

We know the brain while “sleeping” can still be “aware” of noise (when it reaches a certain intensity (loudness) threshold and responds to it through body motility, even full awakening or “regressing” in its process of reaching various stages where vital restorative recovery of normal brain function occurs. Sleep disruption occurs with audible and, likely more importantly with IWTs, with lower frequency noise. The WHO has recently listed wind turbines as a potentially important source of environmental noise. While “high-level correlative data” does not exist yet, the WHO lists noise thresholds for potential disease development at levels lower than road traffic. Other analyses using severe annoyance metrics that include ILFN exposure drive the threshold noise levels much lower yet. Observing current, more inclusive definitions of health, IWTs do produce AHEs as annoyance (from mild to severe), and have been shown to disrupt normal sleep stage progression.

Utilizing metrics of biologic plausibility, as described by Sir Austin Bradford Hill, if met, can establish a “causal link” between WTN and AHEs for epidemiological purposes. As examined by Jerry Punch and Rick James in their 2016 comprehensive review (ref. in text), all 9 of The Bradford Hill criteria have been identified in the scientific literature as pertinent to the relationship between IWT noise and AHEs. Dr. Hill states, *“None of my nine viewpoints can bring indisputable evidence for or against the cause-and-effect hypothesis and none can be required as a sine qua non. What they can do, with greater or less strength, is to help us to make up our minds on the fundamental question – is there any other way of explaining the set of facts before us, is there any other answer equally, or more likely than cause and effect?”* In his final address observation, he asserts: *“All scientific work is incomplete – whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time.”*

Finally, included at the end of part #15, Mathias Basner, MD, PhD – who is considered a world leader on health effects from environmental noise, produced an editorial (2019) where he reviewed the potential impacts of noise on our health. He acknowledged the problem of smaller populations in currently available studies which make statistical powering of conclusion difficult. He has stressed that NONE of the wind noise guidelines data from the 2018 WHO report found an “absence of risk”. He finished his comments with *“the fact that more*

*studies are needed should not lead us to postpone the urgently needed protection of the population from noise."* The knowledge we have acquired so far IS SUFFICIENT to take preventive actions and substantiate them with respective legal noise regulation.

We have all learned that all people suffer to some extent— it is part of being human. But to intentionally force suffering upon affected citizens for the financial benefit of others is immoral. To “mentally take refuge away from guilt” by assuming huge “pinwheels spinning in a neighbor’s field are **silent**” and believing Wind Energy’s mantra of ‘no credible evidence’ that IWTs cause human harm is patently disrespectful, unprofessional, immoral, and grossly irresponsible. We can and must do better.

**Needed Declarations:**

1) I am a Cardiologist who specializes in heart arrhythmias (Electrophysiologist) who focuses on abnormal fast and slow heart rates/patterns, implantable device (pacemakers, defibrillators) therapy, and have participated (investigated, published and presented) clinical research for decades. I also have been privileged to be involved with human research and served as the Chairman of the City-Wide Investigative Review Board overseeing the ethical conduct of ongoing local clinical trials. In those patient trials, high standards of participant protection and adverse event evaluation was paramount. I am drawn to understand the societal (local and international) impacts of IWTs – particularly health. I also felt compelled, through my years of human research experience, to protect the health, safety and welfare of myself and my fellow citizens.

2) I am not an Acoustician. An Acoustician is defined as an expert in the branch of physics concerned with the properties of sound. I have, however, corresponded at length with several Acousticians who have “specialized” their acoustical practice into the understanding, measurement and regulation of industrial wind turbine noise. They have shared with me their acquired in-depth understanding of IWT noise and its impact on people – from the details of measuring and interpreting noise to the impacts of that noise on people’s lives. They have directly talked and worked with the victims of IWT noise exposure. They have been invited into these unfortunate people’s homes and first-hand have measured, experienced and, on several occasions, have themselves suffered serious adverse health events from those noise exposures. They, through their professional lives, have seen the unfolding of IWT introduction around the world, interacted with key both pro- and anti-wind experts, and from their unique vantage point, provided a clearer understanding of the “real issues” and the history behind those issues. They have presented at national societal meetings, offered insightful theories and clarifications to their worldwide colleagues, published peer reviewed papers, testified in court trials, and at the request of governments. They are members of the Institute of Noise Control Engineering (INCE) and/or the Acoustical Society of America (ASA). The INCE/ASA Member has experience in noise impact assessment, the effects of noise on people, and control (complaints, annoyance, noise specifications) and is committed to their Canon of Ethics for unbiased professional services whose first mission is to protect the public’s health and welfare. They are motivated to move forward into the “headwinds of greed and misinformation” because as professional experts,

“they care about people”.

3) The origins of the information I have presented and summarized, I believe to be reliable, verifiable and accurate. I, in no way, have manufactured history, slandered nor created (recently popularized) “alternative facts”. I have expressed personal opinions based on collected information that I believe to be factual. My “physician opinions” come from four decades of interviewing, examining patients and applying basic human physiology and medical science in the effort to protect and improve their lives. I have read and re-read reviews and individual papers from both sides of the argument. In the enormous “confusion” of pro- and anti- Wind information, I have tried to focus on the quality of data being mindful of bias and full disclosure of and composition of reported “peer review” entities. I have looked specifically for the origins of noise regulation and the process by which current IWT siting practices became established.

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July 1, 2020

Board of Zoning

Madison County, Iowa

Re: Wind Turbine Ordinance for Madison County, Iowa

Dear Madison County Board of Zoning Members,

I have submitted his letter to support the process of obtaining a Wind Ordinance that best reflects the health, welfare and safety of our county. I am a board-certified Adult Cardiologist and Cardiac Electrophysiologist who lives in Madison County. As you very well know, the choice of having industrial wind turbines (IWTs) placed in our county is extraordinarily contentious. They are advertised as "green, less expensive and sustainable". The last several decades have seen a worldwide surge in the placement of these industrial-dimensioned turbines - beginning mostly in Europe and eventually coming to the U.S. where onshore implementation has been pursued aggressively. Studied very extensively in the mid-1980s, IWTs were rejected (seemingly) by the federal government, due to concerns of potential serious health hazards. The merits of those intensive studies finding harmful noise production by large-scale industrial wind turbines remain to this day and have never been discredited by Wind Energy. Industrial Wind Turbine approval and regulation have now been passed to states, and in some cases (as in Iowa), local municipalities and counties. Understanding all the complex issues of health concerns related to IWTs has taken, to date, nearly 2 years of my focused inquiry. New health concerns are raised continuously as independent research around the world continues. The Macksburg wind farm was placed several years ago. Currently, the Arbor Hills wind farm extension from Adair into Madison County is on hold pending the Iowa Supreme Court review of the procedural compliance by Madison county's Board of Adjustment in July, 2018 in a 3:2 vote to proceed with IWT placement.

As you know, the Madison County Board of Health (BOH) solicited and obtained information from local citizens, health professionals as well as Mid-American Energy. They were given enormous amounts of information to review and carefully consider in their consideration of the health impact that IWTs would have on the health of the county. They considered scientific information that was current at the time of their public hearings with a considerable amount of new information becoming available since the time of the initial Mid-American Energy proposal presentation. Concern revolved not only around "annoyance" which has been deemed a health risk by the World Health Organization but also included more important concerns of sleep disturbance and chronic autonomic nervous system "hyper"-activation that, over significant time, may pose a risk to chronic cardiovascular disease and other



adverse health events. The BOH voted 2:1 declaring a potential adverse health risk exists with exposure to industrial wind turbines. They recommended, based on extensive data and peer-reviewed summaries (mostly the Punch/James article) that IWT setback should be 1.5 miles from property lines.

Of note, Madison County is NOT alone in their country governance process that includes a required opinion from the County of Health. In Chautauqua County, New York, the Board of Health Meeting on November 21, 2019 that called for a 1.5- mile setback and 35 dB(A). They requested that other municipalities in New York state to do the same. They are supported not just by their BOH but also the Western New York Health Alliance and the New York State Association of County Health Officials.

The 2016 review by Jerry L. Punch and Richard R. James "Wind turbine Noise and Human Health: A Four Decade History of Evidence that Wind Turbines Pose Risks" is, in my estimation, the most complete and fair review of this highly contentious topic.

You may find this Link extremely informing:

<https://hearinghealthmatters.org/journalresearchposters/files/2016/09/16-10-21-Wind-Turbine-Noise-Post-Publication-Manuscript-HHTM-Punch-James.pdf>

Their science-based review is organized by summarizing the past and present literature that addresses each of 12 selected statements that encapsulate specific claims or positions commonly taken by advocates for the Wind Industry. On page 5, Table 2 on page 28 in this publication are listed recommended minimum siting distances and maximum noise levels of industrial wind turbines based on the protection of human health. Seven referenced setback distances were listed with four recommending 1.25 miles or 2 km setbacks. The greatest distance listed was 4 km to protect against enhance amplitude modulated turbine noise which originates from the ILFN (infrasound, low-frequency noise) spectrum which Wind Energy denies poses any risk to humans. The shortest distance was 0.5 miles but with concomitant sound level requirements which would be impossible to achieve with the very large MAE proposed 2 MW IWT for Madison County.

Those concerns were felt to be reasonable and probable given the October, 2018 World Health Organization position document on Environmental Noise and Health as it concerned exposure to other (analogous) forms of noise from traffic, railway and aircraft noise. The key contentious point was that data was currently not "robust" enough nor "specific to" IWT noise to prove that IWT exposure caused sleep disturbance disabilities and, long-term, directly caused cardiovascular disease such as hypertension and facilitated atherosclerotic disease manifested as fatal and non-fatal myocardial infarctions. There was no disputing data but the quality of the data was deemed "conditional" by the WHO. Yet, importantly, the WHO for the first time, issued average exposure noise levels for IWT emitted noise (unwanted sound) as it did for the other 3 prior-tracked environmental noise sources. Concerns were raised about IWT noise in previous 1999, 2009 as well as the 2018 statements. All statements primarily revolved around the adverse health consequence of sleep disturbance.

It is important to recognize that MAE representatives during the public hearing in our courthouse and quoted by Wind Energy over the last 35 years used the phrase: "if you can't hear it, it won't hurt you"

when referring to potential adverse health effects arising from IWT production of "infrasound" noise. I very strongly disagree with MidAmerican Energy's glib statement having dealt with health consequences of "provoked" autonomic nervous systems in over 35 years of practice of subspecialty cardiovascular care. Like carbon monoxide, methane, radon gas from basements, radioactive fallout, inhaled asbestos - among many examples - what you can't hear (and in those cases, also can't see) **can** hurt and even kill you. Although long suspected that chronic noise exposure - including infrasound - was harmful, the objective nature of those risks is now being quantified.

I would agree that connecting minimal, let alone loud levels noise to hard endpoints of disability and even death is not intuitive. The vast majority of people think that IWTs are "**silent**" as their blades turn. That is what the general, unexposed public have come to imagine as they pass them on the interstate at 70 miles an hour with their windows closed or even open given all they could hear would be "background noise" of the turbulent air flowing through the window opening. One must drive to operating IWT sites in the country, park in the "midst" of the operating turbine forest, get out of the car and simply listen, and focus and think about what that complex "clawing/scraping" noise that you can hear and infrasound that you can't "hear" but could "perceive" during sleep - especially if you become unlucky enough to become sensitized (hyperaware) to those sound emissions. Even more informational to understanding the true impact of IWT noise is listening to the turbines operating in the late evening at a time someone would be trying to fall asleep.

Fortunately, as you live your life - in your home or at school or work - if you live far enough away from that noise source, the immediate consequences of annoyance and the much later potentially serious health consequence of audible, infrasound and low-frequency noise can be largely avoided. I wish the citizens of Madison County to have both the rights to rent their land to Mid-American energy for electricity production AND to enjoy the right to live in a truly healthy environment where they safely raise their children and grow old and enjoy their chosen rural lifestyle and where Nature is not threatened by oscillating blades. The only problem is that MAE has offered some of our citizens the chance to lease land for monetary gain but with turbines so big and powerful and of such a design that they pose serious health risks to others if placed too close to their neighbor's property line which is almost always within the range of harmful IWT noise travel. Indeed only 22% of landowners having easements in The Madison County portion of the Arbor Hills proposal would be exposed to the noise exposure they accepted in return for money while nearly 75% of actively polled nearby resident **do not want them** principally because of what they have learned about the health risks.

I launched into this in-depth learning experience because I care about how these will affect our countryside - health, wildlife, property values, view scape among many other reasons. I immediately suspected motives and perceived lies and later learned of "captured" behavior and "conflicted" elected officials who have been given the privilege and responsibility of voting for us and our health and quality of life. The mere elimination of an easement contract to allow a supervisor to very actively promote the preferred language of Wind Energy's requested ordinance does not eliminate their current conflict or future conflict. My motive of speaking up is for transparency and accuracy of data in areas with which I am familiar.

I would ask that you read what you can in the time that you have.

**Suggestions for Manual Use:**

This information has been structured to allow focus on different aspects of IWT consideration.

**Part 1** is the introduction.

**Parts 2 through 13** cover basics of sleep, wind basics and types of IWT emissions. The history of our understanding of IWT noise emissions and the extremely important "evolution" of the current sound level limits as proposed by the World Health Organization (WHO) that are completely ignored by MAE. I spent a lot of time describing adverse health effects (AHEs) with particular concern about Wind Energy's denial of infrasound contributions to adverse health effects - modern, science-supported data is provided in stark contrast to their "non-response". I also included a variety of other topics - ALL of which are relevant in considering IWT intrusion into our county. I reviewed peer review and included critiques of Wind Energy's favorite ACWEA report. Although I will be the first to say that I don't actively "dig up dirt", becoming familiar with an organization's agenda is important and some extraordinary past actions by Vestas are included for your review and thoughtful integration into the manner of their proposals and starkly limited amount of information that their product is safe for our fellow citizen. Again, these are my opinions. I discuss my views on carbon management and what Iowa should be focusing on. Critical points about noise regulation is covered in part 11 with important concepts of ordinance examples and regulation then finally recommendations are given. I would very strongly request your consideration of requesting more accountability and oversight for MAE or other Wind Industry firms. Remember, they don't live here, we do.

**Part 14** is the Summary which is much shorter than the accumulation of information in parts 2-13 and would serve as the quickest way to begin to be conversational about this complicated topic.

**Part 15** is my Conclusion which focuses on adverse health effects. There I provide statements from the best sources I can find with their opinions and suggestions. We all agree.

I have included various graphs and statements provided in the various "parts". Please review them. I would very strongly ask you read a speech given to Vestas in Denmark by a Danish national health care spokesperson, Dr. Johansson. In three page he exposes what we now are witnessing in Iowa.

We need to see this Wind Ordinance crafting as an opportunity and a need to protect ourselves. It should not promote reckless development with short-sighted gains - with most of those gains not going to this county. One should fairly request provisions that ensure compliance and safety. If Supervisors say that "if you make it too complicated and restrictive, they won't come". That is industry's problem. We only are asking for respect and concern for our health and way of life. Our Wind Ordinance should reflect our stated responsibility to protect the Health, Safety and Welfare of Madison County, Iowa.

Thank you for your Commitment to our County's future.

W. Ben Johnson, M.D.

**Part 2 Sleep:**

**Importance:**

The majority of the industrialized world struggles to obtain adequate and restorative sleep. We constantly weigh exhaustion with the need to accomplish more. Work schedules vary and are consuming and pressurized. We balance our needs with the needs of our families finding little time for ourselves. Inadequate sleep begets mental and physical stress which begets chronic mental and physical disease.

Disturbed sleep is the most concerning adverse health effect from industrial wind turbines. It is the key to a cascade of adverse physiologic consequences that may, in the extreme, be associated with a host of potentially serious cardiovascular outcomes. While it is clear that such a relationship exists from exposure to automobile and train and aircraft noises, the data is not robust enough to confirm the same concerns with industrial wind turbines although there is rapidly accumulating data to support that association.

It has, however, reached scientific support to invoke a "Precautionary Principle" as adverse health consequences may be serious consequences and proposed wind farm development is extraordinarily expensive, multiple decades long in proposal and is highly unlikely to achieve the goal of being clean or renewable. The "precautionary" principle has been defined as a broad, epistemological, philosophical and legal approach to innovations with the potential for causing harm when extensive scientific knowledge on the matter is lacking. Epistemological relates to the theory of knowledge, especially with regard to its methods, validity and scope and the distinction between justified belief and opinion. I believe that current science does provide a "justified belief" and NOT mere opinion even in the matter of IWT noise and triggering cardiovascular disease. This principle emphasizes caution, pausing and review before leaping into new innovations that may prove disastrous.

It is worthwhile reviewing the process and importance of sleep thus recognizing the profound implications of appropriate siting of turbines to lessen the consequences of sleep disruption in their homes. Increasing "setback" distance from residence to IWT is the ONLY way to lessen wind turbine adverse health impacts.

Non-REM sleep typically occupies 75-80% of total sleep each night. This period provides time for essential brain function recovery - tissue growth and repair, energy is stored and hormones that are essential for growth and development are released. REM sleep typically occupies 20-25% of total sleep each night. This phase is when dreaming occurs, is essential for processing and consolidating emotions, stress and memories. It is reportedly vital for learning and stimulating the brain regions used in learning and new skill development.

Non-REM sleep transitions through 3 successively "deeper" sleep levels during the night with increasingly longer, deeper REM periods occurring toward morning. If the REM or non-REM cycles are interrupted multiple times through the night (either as brief, non-conscious arousals or as periods - however brief - of awakening) then we may fail to reach the "deeper" periods of sleep where these

"recharging events" can occur. Consequences of interrupted, non-restorative sleep include feeling drowsy, irritable or depressed. Task efficiency decreases particularly with learning, remembering or making decisions. One can crave more unhealthy foods, which could cause weight gain. It has been described that quality sleep is as essential to survival "as food and water". As stated by the National Institutes of Health, "Sleep affects almost every type of tissue and system in the body - from the brain, heart and lungs to metabolism, immune function, mood and disease resistance. Research shows that a chronic lack of sleep, or getting poor quality sleep increases the risk of disorders including high blood pressure, cardiovascular disease, diabetes, depression and obesity".

The importance of reaching the "deeper" phases of sleep were highlighted with 10/31/2019 article published in the journal "Science" studying humans in deeper, non-REM sleep (confirmed with brain wave (EEG) recordings) while undergoing MRI imaging that measured the blood oxygen levels in the brain and how much cerebrospinal fluid (brain "crankcase oil") was flowing in and out over the surface of the brain. They discovered that in this portion of non-REM sleep, neurons start to synchronize (turning off and on at the same time). During the momentary periods when cells were "off", they didn't require as much oxygen, so less blood (flow amount determined by vessel reactivity to need) would flow into the brain that effectively created a larger residual space within the skull surrounding the brain. At that time, cerebrospinal fluid would then "rush in", filling in the space left behind from the decreased blood volume in the vessels thus facilitating "waves" of cerebrospinal fluid to circulate around the brain effectively removing metabolic by-products that accumulated during the prior day.

Your need for sleep and your sleep patterns change as you age, but this varies significantly. Babies initially sleep as much as 16 to 18 hours per day which may boost growth and development (especially of the brain). School age children and teens need about 9.5 hours of sleep per night. Generally, adults need between at least 6-7 hours. After age 60, nighttime sleep tends to be shorted, lighter and interrupted by multiple awakenings. Elderly people are also more likely to take medications that interfere with sleep. For these reasons, our younger and older county residents are considered more vulnerable in their age-related obstacles to achieve restorative sleep. In general, people are getting less sleep than they need due to longer work hours and the availability of round-the-clock entertainment and other activities. The idea of "catching up" on weekends actually never can be fully achieved.... although one may try...."sleeping-in on weekends" has been recently associated with heightened degrees of insulin resistances measures than simply returning to a normal sleep pattern.

### **I Have Seen the "Face" of IWT Harm**

Three years ago, while inquiring about used farm machinery, I sought out a farmer who lived nearby in Guthrie county. Arriving at his farm perched along the "Mo-Miss Divide", I was fascinated at the distracting "surging" of spinning IWTs "for miles". Greeted by the farmer, I asked him about how "he and the turbines" got along. He noted that "a lot of people had moved away, and over half of those who agreed with their easement signing now regret having done so." Looking into his face, I could see the likely signature of chronic sleep deprivation (a distinctive appearance that I can easily recognize in those sent to me for atrial fibrillation consultations who have concomitant obstructive sleep apnea). His speech was a bit halting and searching.... I asked how his sleep was and whether he thought the

turbines had created a problem sleeping. Looking inward, he paused, then scanned the ongoing turbine "wind chopping" and looked down then back up at me. "I don't think so... maybe you get used to it. A year ago, I built a new bedroom addition to my house putting in the best materials I could find with 2x6 construction, thicker insulation and heavier sheathing. It made it better.....(he paused) ...but on those windy nights I can still hear and feel that pounding...."I sensed an exhausted man who had resigned himself to "deal with it". He was imprisoned on his own farm with his entire livelihood around him.

### **Disturbed Sleep - A Worsening Modern Health Epidemic**

We are a society plagued by increasing obesity (now about 40% of Americans are considered as obese with 7.7% being severely obese). The American Heart Association has now included obesity and severe obesity in children as cardiovascular risk factors. With the recent redefinition of hypertension going from 140/90 to 130/80, now >46% of American are considered hypertensive. The incidence of type II diabetes (the type related to "high" insulin levels due to acquired resistance of insulin action at the cellular level) continues to increase in incidence. Somewhere in this "modern health epidemic" is the problem of sleep quality and quantity. The 2019 annual statistical update from the American Heart Association included a new section on sleep and cardiovascular health cited data from the Centers for disease Control and Prevention that only 65% of Americans have a healthy sleep duration (at least 7 hours).

### **Recent Absolutely "Key" Large Scale Studies Linking Inadequate Sleep to Cardiovascular Events**

Recent recognition that restorative sleep - quantified as total duration of sleep that is "effective" - if less than 6 hours per night has been associated with objective "end-points" of disease progression.

Dr. Dominguez noted a "graded response" evident in the PESA (Progression of Early Subclinical Atherosclerosis) trial. This large trial (3974 middle-aged Madrid bank employees free of known clinical cardiovascular disease or history of stroke), wore a waist band activity monitor (actigraphy) for a week to record sleep quantity and quality. Movement during attempted sleep reflects often unconscious "brain awakening" that if brief (<15 seconds), may not remembered as having occurred. They also underwent 3-D vascular ultrasound and measurements of coronary artery calcium (via CAT scanning). The actigraphy confirmed common under-reporting of sleep duration (patients reported 10.7% had < 6 hours via questionnaire vs 27.1% via actigraphy. Multivariate analysis was performed adjusting for smoking, hypertension, physical activity, depression, OSA, daily calories, alcohol intake and other confounding variables. The investigators noted that subjects who slept < 6 hours/night had a 27% greater volume of non-coronary plaque than those who slept 7-8 hours. They also had a 21% more vascular territories (seen on CAT Scans identified with dense calcium imaging integrated in arterial cholesterol plaque formation) laden with subclinical atherosclerosis - women>men in measured effect. The presenter also stated that the more times an individual typically awoke per night, the greater the number of atherosclerotic carotid or femoral artery territories were documented on 3D vascular ultrasound. The statistical power of this study was extremely high (extraordinarily unlikely by chance to be incorrect).

In another study, cardiovascular investigator Fountas (in Athens) reviewed 11 prospective studies correlating daily sleep duration (self-reported) and cardiovascular morbidity and mortality. Collectively 1,000,541 patients (assembled from many similar, but smaller studies where available data could be combined for better statistical power for subsequent larger population analysis - termed "meta-analysis") without baseline clinical CV disease were followed an average of 9.3 years. Data were adjusted for confounding features. He found that if average sleep was < 6 hours, they had a statistically significant and clinically meaningful 11% increase in the risk of a diagnosis of fatal or non-fatal cardiovascular disease as compared with those sleeping 6-8 hrs. Moreover, those sleeping > 8 hours had a 32 % increase in those endpoints compared to 6-8 hours. (Longer sleep duration possibly related to morning exhaustion prompting additional sleep hours to "catch-up").

Both investigators highlighted the pathophysiologic changes related to sleep deprivation that likely increased the pathophysiology of the risk - sympathetic activation, increased inflammation and disrupted glucose metabolism. Again, inadequate or disrupted sleep was very highly statistically correlated to greater cardiovascular disease and their clinical events.

#### **A YouTube Documentary worth seeing**

[https://urldefense.com/v3/\\_https://www.youtube.com/watch?v=vRpsO9qAX\\_A&t=1708s\\_!!CqLitYr3mSQ!ReCVeyUsTjv4BMmYx88rScisOuiYIMMwbnL4GAtN8Zj\\_1kLP8YXO-Z8zJaMCjv1rGRY\\$](https://urldefense.com/v3/_https://www.youtube.com/watch?v=vRpsO9qAX_A&t=1708s_!!CqLitYr3mSQ!ReCVeyUsTjv4BMmYx88rScisOuiYIMMwbnL4GAtN8Zj_1kLP8YXO-Z8zJaMCjv1rGRY$)

The documentary reviews that absolute disconnect of "city-folk" with the realities of IWTs. A community assaulted with IWTs is interviewed... revealing the exhaustion in their lives and chronic nonspecific illnesses - nausea, headaches, etc. and importantly, a lot of dog/pet as well as livestock deaths. Particularly ocular problems were noted with blindness. One of the men interviewed had a lot of eye blinking and trouble focusing - all reflective of eye fatigue not uncommonly experienced by residents. I raise the concern of resonance vibration of fluid filled ocular structures near 5 Hz (infrasound) that could create the symptoms. Although a potentially serious problem, but because IWTs have never been evaluated for safety, it was never (with no current plans to) formally evaluated. The finding of the "enlarged organs" found with necropsied pets has also been seen and commented upon by other physicians - again, we allow these processes to continue unevaluated.... apparently unconcerned about finding out the truth.

#### **Disrupted Sleep Due to IWT Noise Emissions**

Inadequate or disrupted sleep is the most common complaint from residents living near IWTs. It is extremely important to realize that not only does excessive audible noise cause, but with amplitude modulation from the ILFN noise spectrum occurring up to 3-4 km from a household, sleep disturbance can continue even with "reasonable distance, e.g. one-half mile" separation to avoid (usual) higher frequency audible noise. Sleep is "disrupted" through both unconscious arousals and with frank awakenings - both disrupting the healthy progressions through both non-REM and REM sleep periods.

At the 1500-foot setback proposed by Mr. Clifton (Madison County Supervisor), **average** sound levels (expressed as Leq) will be 45 dBA as measured outside the house as predicted by computer modeling.

45 dBA Leq means that there may be recorded peak/nadir or high/low values as another 6-11 dBA above/or below the 45 dBA Leq average. Albeit much less frequent than the average value, audible sound levels of 56 dBA are possible. Testimony under oath by Wind Energy representatives have confirmed these possible noise ranges that are expected from IWT sources. It also means to achieve bedroom levels of 30 dBA your windows will need to be closed tightly with all exterior audible sound not exceeding 45 dBA. Opening the bedroom window even a little (cracked 6 inches) for cooling or fresh air circulation will markedly increase noise entry into the bedroom - enough to necessitate IWT separation another approximately 2000 feet farther to achieve the same interior audible levels as when the windows were closed.

ILFN poses an **even greater** threat to sleep disruption. ILFN generally attenuates at half the rate as does audible sound. This means that (roughly) to achieve the same reduction in noise levels for audible sound, you have to go twice as far to achieve the same noise level with infrasound. Infrasound travels to some extent by resonating in the ground that can then easily resonate a house foundation and structures within the house - being insignificantly lessened by wall/roof insulation. ILFN "sound travel" is frequently described as "amplifying" in the house. Low-frequency noise is audible being 40-60 dBs in the 20-200 Hz range. This would be hard to ignore without sound protection equipment (ear plugs). The sounds in that frequency range are heard/perceived by people in their beds at night when the house is otherwise quiet as "vibrations", rumble and roar. While not particularly "loud", they are perceived because there are no other noises in the community to provide masking of these low frequencies.

The details of sleep are important; the implications of chronic sleep disturbance are profound. Most adults know very little about what happens during sleep. Sleep Medicine is one of the most recent additions to an ever-increasing range of medical specialties. It should NOT be viewed as esoteric and beyond understanding...in fact, some of the most recent science is available at newsstands, on-line and delivered to your home. In a recent "double issue" of TIME magazine (August 17/24<sup>th</sup>, 2020), the editors dedicated 14 pages of the issue to the topic "How to sleep better – the changing science, business and culture of a good night's rest". One subsection was entitled "What exactly is your brain doing while you sleep?" and was highlighted with the words: "New Research on its physiology shows why we need to take slumber seriously".

In the third paragraph they write, "In the past five years, brain researchers have begun to expose a hidden world of chemical reactions, fluid flowing into and out of the brain, and the busy work of neurons that reveal the sleeping brain is as industrious as the waking one. Without good-quality sleep, those critical activities don't take place, and as a consequence, we don't just feel tired and cranky, but the processes that lead to certain disease may even get seeded. One of the reasons we sleep, it now seems, might be to keep a range of illnesses – including cognitive disease like Alzheimer's and other dementias – at bay". They then described the association of "build-up" brain amyloid and another protein called "tau" associated with patients suffering from Alzheimer's disease. In mice, they confirmed those protein levels "dropped dramatically – especially during the deeper stages of non-REM sleep". In mice chronically deprived of non-REM sleep, more amyloid built up in their brains over time than in mice



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who got regular nightly rest. Similarly, (Holtzman, the researcher) saw similar changes when he compared amyloid in the spinal fluid of people who were well rested vs. sleep deprived. The article continues describing even more promising confirmatory data and ongoing longitudinal studies.

In that same TIME “sleep-focus” set of articles, another writer wrote: “There are many scientific reasons to desire good sleep. Poor sleep quality is associated with a whole host of unhealthy side effects. Getting bad sleep puts people at a higher risk for diabetes, cardiovascular disease, Alzheimer’s, impaired memory, problem-solving issues, fatigue, anxiety, mood disturbances and poor performance at work.” Another comment included “The keys to good sleep, I’m told, are simple: exercise; eating well; not drinking too much; a dark, quiet space; creating a wind-down routine; no “screens” two hours before bed; and a comfortable bed. The greatest enemy of sleep is “stress.” In my opinion, speaking to the last listed point, the presence of inescapable, non-ignorable large, intermittently rotating massive structures – creating noise while adversely affecting the environment and property values - creates a “lingering” stress that is consciously and unconsciously “recognized and felt”. Humans are continually trying (often unsuccessfully), to “resolve or normalize” such intrusions. That strife resolution is ongoing and likely contributes to sleep disruption and annoyance suffering.

In another section, comments from Dr. Louis Ptacek, a neurology professor at the UCSF, commented “human sleep is largely a mystery; getting too little is linked to heightened risk for metabolic disorders, Type 2 diabetes, psychiatric disorders, autoimmune disease, neurodegeneration and many types of cancer. It is probably true that bad sleep leads to increased risks of virtually every disorder”.

I ask, “Why should we not protect ourselves (not only our health but also including our well-being, our families, our properties) through the active protection of our ability to have quality sleep?”

## **Appendix:**

The following table appeared in the World Health Organization Executive summary in 2009 although it had also been published in 1999. Current experimental Sleep Research continues to support the listed sleep disturbance threshold values.

Effect	Indicator	Threshold, dB
Biological effects	Change in cardiovascular activity	*
	EEG awakening	$L_{Amax, inside}$ 35
	Motility, onset of motility	$L_{Amax, inside}$ 32
	Changes in duration of various stages of sleep, in sleep structure and fragmentation of sleep	$L_{Amax, inside}$ 35
	Waking up in the night and/or too early in the morning	$L_{Amax, inside}$ 42
Sleep quality	Prolongation of the sleep inception period, difficulty getting to sleep	*
	Sleep fragmentation, reduced sleeping time	*
	Increased average motility when sleeping	$L_{night, outside}$ 42
Well-being	Self-reported sleep disturbance	$L_{night, outside}$ 42
	Use of somnifacient drugs and sedatives	$L_{night, outside}$ 40
Medical conditions	Environmental insomnia**	$L_{night, outside}$ 42

**Table 1**  
**Summary of effects and threshold levels for effects where sufficient evidence is available**

\* Although the effect has been shown to occur or a plausible biological pathway could be constructed, indicators or threshold levels could not be determined.

\*\*Note that "environmental insomnia" is the result of diagnosis by a medical professional whilst "self-reported sleep disturbance" is essentially the same, but reported in the context of a social survey. Number of questions and exact wording may differ.

Taken from W.H.O. 2009 EXECUTIVE  
SUMMARY

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**Part – 3: Wind Noise “Basics”**

**Wind Turbine Noise:**

**Sound Spectrum Defined by Frequency**

Audible noise 20-approx 15,000 Hz (adult)

Infrasound 0.1-20 Hz

Low-frequency sound 20 to 160-200 Hz

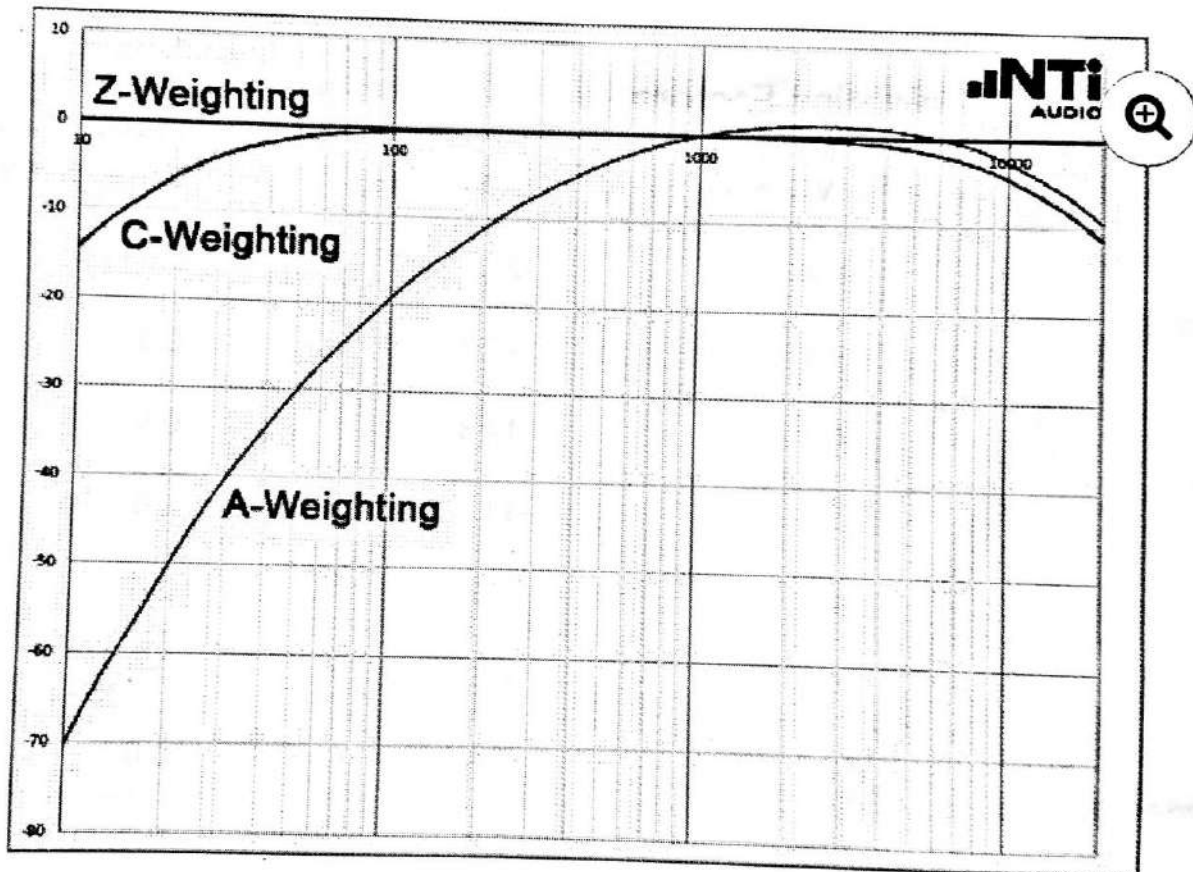
the term "ILFN" combines infrasound and low-frequency noise together.

Note: That "loudness" (or sound pressure) is measured in decibels (dB) and is quantified on a logarithmic scale meaning, e.g., that increasing the measured loudness of a sound from 30 dB to 40 dB (at 1000 Hz) is approximately 2 times louder (not 25%). The relationship of dB change to loudness varies with frequency where change occurs. (See below)

**Sound Measurement and "Filter Effects" – Use with IWTs and What it Does and Doesn't Measure**

Standards for describing sound levels or limits are set in decibels. Use of "dB(A)" with A, C, G, L, Z classification reflects the filter used during measurement. "A" has been used as the standard descriptor filter around the world but excludes accurate measurements of frequencies below 200 Hz, including both infrasound (0-20 Hz) and low frequency noise (20-200 Hz). This glaring "under-measurement" of the true "quantity of infrasound using only "A weighting" to describe the whole noise spectrum was a product of the ETSU-R-97 wind turbine siting guideline by the BWEA and the British Department of Trade and Industry. This guideline was developed specifically to circumvent more science-based UK regulations that were more restrictive to IWT placement. As such, it is important to recognize that A-weighted loudness measurements will generally only reflect audible noise content which could also contain potentially harmful inaudible sound content - particularly when used with IWTs. National "standards" in Australia do not require infrasound (either within or outside homes) to be predicted in planning submissions nor to be measured in the required compliance testing to the planning permit noise conditions. Most jurisdictions do not require wind turbine-generated low frequency noise to be predicted or measured (unlike other sources of industrial noise). In fact, most noise measuring instruments and microphones are unable to measure accurately in the infrasound range, especially below 8 Hz., and some standards explicitly specify the use of equipment which cannot measure infrasound. Having said that, "C-weighting" is available on standard acoustical equipment and is clinically useful to measure environmental low-frequency noise sound pressure levels.

The image below shows the differences of Z- (unweighted) vs both A- and C-weighting. C-weighting will more accurately reflect intensities at various frequencies when applied in the low-frequency noise spectrum: The horizontal axis shows the log scale of frequencies while the vertical axis is in units of decibels.



### Shadow Flicker

This is the effect of the sun (low on the horizon) shining through the rotating blades of a wind turbine casting a "recurrent/pulsing" moving shadow; it will be perceived as a "flicker" due to the rotating blades repeatedly casting the shadow.

**Source of IWT Noise:**

Machinery noise in the nacelle (horizontal containment for machinery - behind hub)

Rhythmic/pulsating, trailing-edge noise from the blades ("blade swish") as they slice through the air at up to 200 mph

Irregular, low frequency noise (LFN) and infrasound from the blades due to in-flow air turbulence

LFN and infrasound at the blade-tower-passage frequency and its harmonics.

**Primer on Sound: What it is, Measurement (Adopted from Waubra foundation):**

Operating turbines create electrical energy inside the nacelle through the rotation of a central axle that is turned by the force of wind pushing on large canted perpendicular blades connected to that axle. Besides the desired generated electrical power, "waste energy" in the form of airborne pressure waves (sound) and ground-borne pressure waves (vibration) are released into the environment.

Noise is that part of the sound frequency spectrum which is audible or can be perceived. "Noise" is defined as unwanted sound.

The strength (sometimes expressed (vaguely similar) as "loudness" in the case of noise) of the sound is measure in decibels ("dB").

The wavelength of individual sound waves is a measure of the distance between the peaks of pressure waves. The speed of sound divided by the wavelength gives the frequency of the sound and is expressed in hertz (Hz)

Where the frequency of the sound waves is below 20 Hz, the distance between the waves becomes relatively longer, and the general term for this portion of the frequency spectrum is known as infrasound. Infrasound is only audible (heard) at sound high levels (dB). However, it can be "perceived" at lower sound levels and be damaging to the human body at levels well below audibility.

Impulsive infrasound from a variety of industrial sources (industrial turbines, HVAC installations) has long been known to have the potential to be harmful to humans, especially with chronic exposure.

Terrain and weather conditions influence noise. The wind speeds and directions upstream of a turbine vary due to:

Terrain effects, such as hilliness and ridge lines

Objects on the surface of the terrain, such as buildings and trees

Daytime thermal effects, temperature inversions

The following contribute to sound levels heard or perceived at residences:

meteorological conditions

wind turbine spacing and associated wake and turbulence effects

vortex effects

wind shear

turbine synchronicity (adjacent IWTs with blades turning with perceived passing of the tower at the same moment - generally is more intense with IWTs lined up parallel to wind direction)

tower height, blade length

turbine power settings

During daytime, as the 3-bladed rotor turns, it encounters air at various speeds and directions which produces a combination of sound effects, i.e. rhythmic/pulsing blade swish about 3 dBA above the steady aerodynamic noise and a steady rhythm of low frequency noise and infrasound. During nighttime, air speeds and directions, not influenced by daytime thermal effects, become more varied, the atmosphere becomes more stratified and background noise is less, causing the various sound effects (aerodynamic noise, rhythmic/pulsating noise, rhythmic LFN and infrasound) to be noticeably more intense than during the daytime. The daytime swish noise often becomes a night-time clapping, beating or thumping noise. (Wilhem Post (On Wind Turbine Noise and Air Pressure pulses))

The so-called upwind vs downwind design of wind turbines can definitely influence turbine sound production. "Upwind" (referring to turbine blade positioning into the wind with blade positioning in front of supporting tower) is almost exclusively used as it produces less turbulence and hence less noise. This was first described in detail by N.D. Kelley in the late 1980s.

People who are not exposed to the sounds of a wind farm find it very difficult to understand the problems of people who do live near to wind farms. Some people who live near wind farms are disturbed by the sounds of the farms, while others are not. As the sound levels increase, a greater percentage of exposed people suffer annoyance. In some cases, adverse health effects are reported, in other cases, such effects do not appear evident. As sound levels increase, the reported incidence of health effects also increase and become increasingly severe. This lack of similar effects to every resident reflects individual noise sensitivities and complex effects on the physical health is confusing to outside observers (at first) but is well known in epidemiological data and normal variations of reactions at a given stimulus strength in populations.

### **Amplitude Modulation (Audible Blade Swish)**

Although there remain differences in opinions about what causes the amplitude modulation of audible

wind turbine noise most of the explanations involve air turbulence around the turbine blades. There are a number of explanations and more than one may apply at any specific wind farm site. For example, eddies in the wind, wind shear (different wind speeds at the higher reach of the blades compared to the lower reach), slightly different wind directions across the plane of the blades and interaction among turbines, have each been identified as causes of modulating wind turbine noise from modern upwind turbines.

The importance of the presence of audible amplitude modulation for wind turbines relates to the subjective annoyance of the audible signal that may warrant an adjustment for that subjective/annoying characteristic. In the frequency domain the fluctuation for a turbine occurs across the entire spectrum. At distances removed from the turbine, the high frequency components are reduced and can alter the audible fluctuations to more of a low frequency noise. At a given site of noise analysis within a field of emitting IWTs, a summation of noise described as "rumble to roar" is appreciated due to the collisions of sound waves - both amplifying and cancelling noise levels. These continuous "modulating noises" can be perceived as extremely annoying.

#### **Variable Noise related to Blade Angle**

The blade can be rotated at the point of attachment at the hub thus changing the canted blade angle with respect to inflow air. The steeper the angle, the more noise. Dr. Van den Berg summarized this in a table in his 2006 thesis. He described the increase of trailing edge sound level as a function of angle of attack. The most efficient power production is when the inflow air allows the turbine to reach full power with a blade angle of 1 degree or less. Thus, in real world operation where conditions are not so perfect, the sounds can exceed the "rated" sound power level used in a model by 11dBA or more (with the angle of attack at 9 degrees).

#### **Wind Turbine Noise is "Distinctly Annoying"**

Wind turbine noise has been described as having a character that makes it far more annoying and stressful than other sources of noise at the same A-weighted level, including airport, truck traffic, railroad or industrial noise. Thorne (acoustician) has pointed out that human perception of noise is based primarily on sound character rather than sound level, and that wind turbines are unique sound sources that exhibit special audible and inaudible modulated and tonal characteristics. He states that sound levels of 32 dBA Leq **OUTSIDE** a residence and/or above an individual's threshold of hearing inside the home are markers for serious AHEs, especially among susceptible individuals. Thorne described IWTs and wind farms as a unique source of sound and noise - like no other noise source. The sounds are often of low amplitude and shifting in character, making it difficult for people who have never been exposed to such sounds to understand the problems of those who complain about the sound. IWT noise is "distinct and annoying enough" to commonly be heard 10 dBA below background noise. It is this annoying property unique to IWT noise that likely causes more "stress" which can occur at "lower sound levels" than other environmental noise sources. This relative "more annoying effect" is reflected in the average Lden (sound level "average" over day-evening-night) ratings assigned by the WHO that are lower for IWT than rail or highway noise.

### "Worst-Case Conditions" Sound Propagation Models

It is noted that consultants for wind utility developers often claim that wind turbine sound emissions inside and adjacent to the project footprint estimated by the sound propagation model's represent worst-case conditions. Models are representations and simplifications of complex interactions between noise emitters and their surrounding environment. For specific situations of modeling noise levels emitted by wind turbines, e.g. in complex terrain, such as sited along ridges and in valleys, understanding interacting factors and creating assumptions that will accurately allow predicted sound levels, can be quite challenging. The ability of the model to accurately replicate how the sounds are blocked by terrain or reflected by terrain is especially weak. **Errors in models of wind turbine noise propagation located on flat terrain have been shown to have errors of 5-10 dB or more** when studied by independent acoustical engineers.

However, it is only true that the input data (power sound level) used for the turbine's acoustic energy represents the turbine's sound emissions at or above its nominal operating wind speeds under standardized weather and wind conditions. That designated power sound level will then permit a prospective buyer of turbines to compare the sound emissions from various makes and models. The IEC (International Electrotechnical Commission) test data does not account for the increased noise from turbulence or other weather conditions that may cause higher sound emissions. Indeed, in the IEC test data, it specifically reports that it is **not** "worst case" for real-world operations. Independent of the effect of weather and wind on the turbine's noise emissions, ANSI (American National Standards Institute) standards for outdoor noise caution that turbulence in the air can increase the downwind sound levels by 6-7 dB or more.

Impulsive sound was considered inherent only with older downwind turbine designs but was found only to be reduced with modern turbine upwind designs. In a landmark 2006 study by G.P. Van den Berg, it was shown that the impulsive swishing sound increases with size because larger modern turbines have blades located at higher elevations where they are subject to higher levels of "wind shear" during times of ground level "atmospheric instability". This results in sound fluctuating 3-5 dBA between beats under-rate moderate conditions and vary up to 10 dBA or more during periods of higher turbulence. To compensate for the added annoyance of fluctuating or impulsive sound, the convention is to add a penalty of 5 dBA to computer model estimates of average sound levels to account for the increased annoyance from short term fluctuations in sound levels. In the Kamperman/James criteria, this penalty is already included in its recommendations for the maximum allowable sound level at the receiving property of 35 dBA.

The only information regarding sound levels to be expected during projected wind farm operation proposed for Madison County, Iowa Arbor Hills Project was "right at 45 dBA" as stated by Matt Ott given during the initial hearings for variance. I saw nothing in the application, that I as a citizen, was allowed to review that referred to produced sound levels.



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Regardless of these complicated factors, objective noise limits, need to stand as the "limit" for any IWT noise production. IWT platting contractors must do their best (and likely remain conservative) as any emission levels about the limits are "not excusable" and should be consider as not being in compliance and thus requiring mitigation/correctional action.

### **Winds Speeds at Night: Contrary to Common Perception**

Popular notion is that wind picks up (increases speed) after sunrise and abates after sundown. This is what is most often seen as experienced at ground level; the opposite occurs above 80 meters. After sunrise low altitude winds are coupled to high altitude winds due to the vertical air movements cause by the developing thermal turbulence. As a result, the low altitude winds are accelerated by the high winds, which through the air mass coupling, in turn slows the high-altitude winds. At sunset this process is reversed. As described by Rick James, "when ground-level wind speed calms after sunset, wind speed at typical hub height for large wind turbines commonly increases. As a result, turbines can be expected to operate, generating noise, while there is no masking effect from wind-related noise where people live (near the ground). The contrast between wind turbine and ambient sound levels is therefore at night more pronounced. As the turbine's blades sweep from top to bottom under such conditions, the blade encounters slightly different wind velocities creating unexpected turbulence that results in rhythmic swishing noise". Such calm or stable atmosphere at near-ground altitude accompanied by wind shear near turbine hub height occurred in the Van den Berg measurements **47% of the time** over the course of a year on average - and most often at night.

**This is a key concept to understand when protecting the conditions for sleep during the night. This concept is the key "deception" propagated in the ETSU-R-97 guidelines pushed by the majority-authoring Wind Energy sympathetic factions in their attempts to evade more restrictive sound regulation based on sound annoyance/tolerance regulations present in the British Standard 4142 regulatory document. The resultant pseudoscience-based "high night-time" (and thus the short set-backs) permitted IWT-generated sound levels have been promulgated by both Wind Energy groups and turbine manufacturers in IWT adoption and spread throughout Europe, Australia, New Zealand and the United States. Wind Energy never talks about it.**

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#### Part – 4: IWT Sound Emissions - Types

As described in Part-3 "Wind Basics", sound emissions are first categorized by their frequencies.

##### Infrasound

Wind Turbines produce infrasound along with audible noise. **The more powerful the wind turbine, the greater the proportion of infrasound and low frequency noise is emitted.**

Sound with frequencies below 20 Hz is labeled as infrasound. It is usually cannot be heard, but actually can be heard at the higher end of the 20 Hz zone while "perceived" at the lower portions provided the sound pressure level is sufficiently high. The sound is perceived with the ears usually giving a feeling of pressure at the eardrums. Infrasound at an audible level is usually found on the car deck of a ferry and when driving a car with an open window. Infrasound is most often associated with sound at other frequencies, so the experience of listening to "pure" infrasound is uncommon.

##### "Perception" Thresholds, Serious Consequences with Larger IWTs Power Generating Capacity

The rapid introduction into rural residential locations at close siting from resident of increasingly larger IWT for the purposes of larger energy production per turbine has been without ANY efforts by Wind Energy to ensure public safety with the new levels of sound production profiles - particularly in the infrasound range. George Kamperman (Acoustician) believes that the amount of low-frequency noise generated by IWTs increases by 3-5 dB for every megawatt of electrical power generated. This is particularly important as MAE has recently placed (in adjacent counties) many 4.8 MW IWTs (nearly 2.5 times greater output than the 2 MW planned for Madison County). Wind Energy disputes that IWTs produce little, if any, infrasound. Furthermore, they believe that within the infrasound range, the sound levels produced are less than the human thresholds for perception. Those referenced thresholds, however, were derived from assessment of "pure tones" which are not type of sounds produced by IWTs. ILFN is more characterized as impulsive and varied. As the human ear "reaches" to embrace detection, when sound is not pure-tonal, noise recognition can extend another 10 to perhaps 15 dB lower (Swinbanks).

Many Acousticians have commented about an easily discernable difference among people to hear sound. The distinct range of hearing capabilities in normal people is the primary basis of the observation that only a smaller percentage of an affected population suffers with noise annoyance which then becomes a larger percentage as the IWT sound levels increase (get louder). It is true that some can hear "better" (quieter levels) than others. AT the "townhall" resident testimonies held throughout Madison County (leading up to the efforts to formulate a Wind Ordinance) approximately 25% of residents voiced a desire to allow IWTs into the county while a passionate 75% did not want them forced into their lives. Several "pro-Wind" comments were from farmers who stated they "could run their tractors all day long under the turbine and never notice them". Such individuals, if wearing hearing protection or riding in a protective enclosed tractor cab, would probably be protected against appreciable audible emissions being generated by the IWTs. If such individuals worked without sound protection, the immediate background noise levels, e.g. tractor engine (and the domination of the

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sound source in the immediate vicinity) from farm machinery, would normally be high enough to exclude a separate, recognizable IWT noise. Even if machinery was not immediately operating, human sound perception "adapts" to the usual background noise level - thus making their "unfocused" listening experience less aware of ongoing IWT sound. Such adaptation may take several days to recover in the absence of background noise associated with mechanized farming.

### **Clear Lessons from N.D. Kelley Pioneering Studies**

Evidence that IWTs produce perceptible levels of infrasound in addition to audible low-frequency noise above 20 Hz has been available since the 1980s (Taken from Punch/James - 2016). Kelley, et al, in response to noise complaints, measured noise levels emitted by the Mod-1 IWT during their seminal multi-year evaluation concluded:

"... one of the major causal agents responsible for the annoyance of nearby residents by IWT noise is the excitation of highly resonant structural and air volume modes by the coherent, low frequency sound radiated by large wind turbines. Further, there is evidence that the strong resonances found in the acoustic pressure field within rooms actually measured indicates a coupling of subaudible energy to human body resonances at 5,12, and 17-25 Hz, resulting in a sensation of whole-body vibrations".

Most importantly, Kelley found that the turbines radiated their peak sound power (loudest in terms of decibels) in the infrasonic range - typically between 1 and 10 Hz. Annoyance was the result of coupling of the turbine's impulsive low-frequency acoustic energy into the structures of some of the surrounding home - frequently confined to within the home itself. Despite these early findings that IWTs generate infrasonic levels that produce acoustic energy, vibrations and resonances that affect people in their homes, the Wind Industry has chosen to regard them as insignificant...

### **Infrasound Emissions from IWTs DO exist**

There has been an intense effort by Wind Energy to "downplay" the existence (if possible) and the potential adverse health effects of infrasound.

The overall mechanisms by which jet engines, aerodynamic structures and wind turbines generate sound was first placed on a rigorous mathematical foundation by M.J. Lighthill in 1952 - nearly 70 years ago. Swinbanks (Acoustician) noted that his analysis has since stood the test of time. The principal process which generates very low frequency infrasound is the effect of the aerodynamic lift force of the blade acting upon the air. Even if a steady, unchanging lift force rotates in a circle, the periodic changes in its position give rise to sound generation. For an ideal wind turbine blade generating power in a completely uniform, steady oncoming airflow, the resultant sound consists primarily of the lowest blade-rate harmonic, plus to a lesser extent the immediate second and third harmonics.

Swinbanks describes the infrasound-generating process as "unavoidable". (The following paragraphs are from his testimony at the Australian Select Committee on Wind Turbines - Submission 189). "If a wind turbine is to provide useful power, it must satisfy two requirements. First, it must slow down the oncoming wind in order to extract its energy. Secondly, it must convert this energy into a rotational

torque to drive its generator. Thus, the blades of the turbine must exert a forward-acting force on the oncoming wind to slow it down, while exerting additional tangential forces in the circumferential direction to give the required torque. These simultaneous objectives are achieved by the twist and alignment of the blades relative to the oncoming wind, so that both components of force can be generated by the aerodynamic "lift" from the blades. For any wind turbine that is generating power, these two rotating force components have to be present. In turn, a specific amount of infrasound is inevitably generated, regardless of how precisely and accurately the blades are profiled, polished and streamlined".

These basic underlying effects were accurately modeled by NASA in their late 1980's investigation of upstream-rotor turbines (type in use today). However, real circumstances introduce additional effects. The existence of the support tower downstream of the blades still requires the airflow to separate around the tower, which gives rise to some degree of upstream modification of the flow directly in front of the tower. NASA initially modeled these effects using the assumptions of a comparatively smooth flow change, but in practice trailing vortices from the tips of the turbine blades can also impact the tower and lead to an increase in infrasonic noise generation. At the same time, slower moving air closer to the ground at the bottom of the blade rotation can give rise to additional recurring transient variation in lift force on the turbine blades. This effect becomes more significant as the diameters of wind turbine rotors increase in size, since the blades then rotate through a much greater vertical distance and the change in windspeed from the top to bottom of the rotation can then be much greater. Finally, any large-scale turbulence present in the incident airflow results in additional fluctuating lift forces which can also interact with and modify the infrasound that is generated.

### **Long Range Propagation of Infrasound**

Infrasound persists for much greater distances than audible sound and, unlike audible sound, penetrates well into insulated building structures with ease; and often increases the impact by resonating within the house, like a drum. This occurs, regardless of the source of sound and vibration energy. Penetration of buildings and amplification via resonance can also occur from sound and vibration from natural sources such as earthquakes and thunder but is of such a temporal nature that, unlike wind turbines, produces no adverse health effects.

Sound propagation varies depending on the frequency of the sound being propagated. Audible sound attenuates (decays) at roughly 6 dB/distance doubling from the source. Infrasound attenuation is roughly half of that because of the longer wavelength being "absorbed and carried" in the "denser" medium of the ground. Infrasonic pulsations from a single 4 MW wind turbine were measured 10 km from their source in 1985 by NASA researcher William Willshire - the presence and recognition of associated adverse health consequences of this low frequency energy component of noise being noted WELL BEFORE commercial IWTs were later pursued. Recent data collected by Acoustician Les Huson in Australia and the United Kingdom at onshore and offshore wind developments has shown that attenuation (reduction in sound level with increasing distance from the source) can be much less than the 3dB per doubling distance found by Willshire in 1985. This means that infrasound noise, in certain situations, can even propagate further than what is commonly described.

Under normal atmospheric conditions, the temperature of the air progressively gets colder as altitude increases. Under such conditions, the propagation of both audible sound and infrasound spreads out and attenuates at a similar rate of -6dB per doubling of distance. There is also progressively greater attenuation of the higher audible frequencies, as a result of atmospheric sound absorption. Under certain atmospheric conditions, however, there may be a temperature "inversion". This can occur particularly at night or the early morning, when the ground and the air immediately above it lose heat faster than the air at higher altitude. Consequently, for several hundred feet or more, the air may actually get warmer with increasing altitude, before ultimately reverting, at higher altitude, to its more usual cooling profile. A similar situation can occur when the wind changes from a cold wind blowing over cold ground, to a warmer wind from a different direction blowing over the same initially colder ground. A well-known consequence of this inversion temperature profile is that low frequency sound can be trapped and reflected by the inversion layer, so that it spreads out more slowly. Its rate of attenuation then reduces to more typically -3 dB per doubling of distance, so that at large distances, although the higher frequencies may be imperceptible, the ILFN can still be clearly detected.

Radiation inversions are probably the most common type of temperature inversions. This forms near the earth's surface during the night. After sunset, especially on a clear night, the earth's surface cools because energy is radiated to space. The air which is just above the earth cools through contact with the cool surface. Many residents in Adair county became upset after the recently erected IWTs became operations with the thumping they experienced during the first winter. They were being kept awake by the readily perceptible modulated low frequency noise and infrasonic "silent thumps" of IWTs at a distance of even 3 miles.

In considering IWT distancing from property lines and resident homes, it is first important to protect humans with audible sound limits - particularly at night - to eliminate disruption of sleep and thereby mitigate that core determinant of AHEs from wind turbines. That established limit of audible sound (expressed in dBA) will have some influence on the omnipresent lower frequencies of IWT emissions, but NOT complete "control". One MUST recognize that infrasound causes health effects and that those effects extend a much greater distance than audible sound. This is a sad reality, if audible sound limits are set high - e.g. >40 dBA at night - there is a marked increase in ill-effects of infrasound at the receptor structure. Distancing is the only way to lessen the harmful adverse effects of IWT noise. Initially defined are lower audible sound limits AND, ideally, secondly defined setback distances (to protect from longer-ranging infrasound) are needed to protect human health. The distance of 1.25-1.5 miles, as recommended by the Madison County Board of Health from their comprehensive review of available independent scientific information, would be appropriate for IWTs of 2 MW or less (although there would be some annoyance suffering, at times, even with that physical separation). Recently it has become apparently that separate ILFN noise regulation limits are needed – typically expressed with C-weighted values

### **IWT Separation and Infrasound**

These following observations are particularly true of wind turbines which are positioned too closely together in a wind farm: The wakes from turbines positioned upstream are convected downstream by

the wind and may compromise the lift forces generated by turbines located further downstream, with resultant adverse consequences for both the fatigue life of the blades and the generation of excess infrasound. The more the "wake deficit" that is brought about by the extraction of energy upstream, the more the reduction of the amount of power that the downstream turbine can generate in a given wind strength. This effect was first intentionally investigated in the design of the 1981 MOD-2 upwind-rotor turbines. Yet despite this early research, more recent examples of wind farms have been constructed with separation in the downwind direction as little as 3 turbine blade-diameters, which not surprisingly have resulted in complaints from nearby residents of excessive noise and infrasound.

Historically it was accepted that wind turbines should be no less than 5-8 rotor diameters apart, depending on the direction and consistency of the prevailing wind, with the larger separation being for turbines in line with the major wind direction. This was accepted industry practice and, as an example, was explicitly specified in the 2002 NEW SEDA handbook. The purpose of this specification is to minimize turbulent air entering the blades on an adjacent turbine. As noted, turbulent air is associated with increased sound levels and infrasonic pulsations.

If a significant proportion of the wind blows at a right angle (90 degrees) from the major direction used for turbine layout it follows that turbine spacing should be 7 or 8 rotor diameters in both directions. It should be noted that the 7-8 rotor diameters number is a compromise between ensuring smooth air inflow to all turbines (and hence less noise and vibration) and packing as many turbines as possible into the project area. Research conducted at John Hopkins University in 2012 showed that the best design for efficient energy extraction suggests wind turbines should be 15 rotor diameters apart. It is increasingly evident that some projects are not laid out in accordance with accepted specifications to reduce turbulence, which in turn significantly increases acoustic emissions including audible noise and infrasonic pressure pulses. It is very important that such "variations of aggressive IWT placements" be recognized as likely and that residence audible sound levels (expressed as Lmax) be clarified precisely such that sound limits enforcement can be made. Additionally, with MAE's practice of turbine "clumping" and close in-line spacing, listing a maximal permissible sound level within the infrasound spectrum would also be protective.

### **Sound Propagation Computer Modeling**

As just noted, it is increasingly evident that some projects are not laid out in accordance with accepted specifications to reduce turbulence, which in turn significantly increases acoustic emissions including audible noise and infrasonic pressure pulses.

There are commercial quality wind turbine computer modeling programs available but are limited to only spherical but not line propagation that could grossly underestimate the true impact of the sounds on adjacent properties located along the rows. These programs also did not follow the advice of the NASA studies about propagation of the infra and low-frequency sounds. Rick James, (Acoustician) commented that it was not uncommon for acoustical consultants hired by property owners to measure sound levels on their properties frequently found levels that exceed the modeled sound levels by 5-8 dBA. He was concerned that models/designs did not reflect "worse case conditions", failed to fully

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disclose assumptions, limitations and tolerances. Finally, they need to consistently provide confidence limits to account for the inherent inaccuracies in any model representing a complex set of conditions.

Recent Mid-American Energy promotional ads have extolled the "advanced quality of the computers they use in siting turbines. Although I do not know exactly what capabilities they have, the pattern of IWT placement in "clumping/groups" and placed in "lines" often congruent with prevailing wind directions suggests computer modeling may not be ideal based on the physics of IWT sound propagation. I would suggest that industry's "dense siting" practice may likely be "inconsistent" with the paramount **primary health concern** of limiting sound exposure to residents.

**For these reasons, among others, an independent sound impact assessment by a qualified member of INCE (Institute of Noise Control Engineering) acoustician is needed and such a requirement should be in the requirements of a County Wind Ordinance. Although there is time and cost required for such a review, future monies saved will be enormous compared to the monies spent (legal fees) over decades by individuals and groups to eliminate or mitigate IWT annoyance produced from a poorly designed, industry-submitted plan. This independent audit should be made available to anticipated residents impacted by IWT placements near their residences BEFORE construction. This essential Wind Ordinance component is mentioned in the recommendations part.**

### **Low Frequency Sound**

The range for this category of sound is usually defined as 20-200 Hz but has also been defined, by some acousticians as 10-160 Hz. Low-frequency wind turbine noise is usually described in its modulating state as a rumbling, as humming or as a roar. It may have a more or less "tonal" character - described as fluctuating and varying in level and/or pitch. It may also be described as having tone-like pulses excited with regular or random intervals. It is often reported as having a feeling of eardrum pressure. It is characteristic that the noise varies a lot in time with varying wind and other atmospheric conditions.

A beautiful representation of "on-going" low-frequency noise modulation was presented at the 2017 ICBEN (International Commission of Biological Effects of Noise) by Dr. Steven Cooper, Acoustician. The one minute visual recording of vacillating low-frequency sound levels (seen as snap-shots of colored lines along with summated averages along the recording duration represented in black) is available at <https://1drv.ms/v/s!AjF3hssMsBNBg5Rs1lRebR87OkWyQQ?e=gDptEi>

You will note that the displayed frequency range extends from 0 to 1000 Hz. "Rumble" characterizes the sound from 20 to 100 Hz, "roar" from 100 to 200 Hz and "whoosh" from 200 Hz and higher. These varying peaks within the noise spectrum, (generally high enough in dBA loudness) will generate audible sound - from which people suffer annoyance.

What you see is a "real-time" FFT analysis (Fast Fourier Transform converts a signal from its original domain (often time or space) to a representation in the frequency domain or vice versa). The black trace is "time-averaged" to slow it down enough to make it easy to see. As "averaged", the true peaks

are not seen. The range of peaks are shown as the colored lines. The "beat" is relatively steady but the amplitudes at any frequency change a bit from one time to the next. This is because there are multiple wind turbines contributing to the acoustic data used to do the FFT analysis. While all turbines may be spinning at the same rpm, they are not perfectly in sync with each other and the sound from each turbine take a slightly different amount of time to reach the microphone. Thus, the black line trace is showing the blending of these similar pulses and tones, sometime adding together to create a maximum, sometimes cancelling each other out creating a minimum.

Leventhal (primary Acoustician for Wind energy) has identified (in his more recent opinion) that infrasound is not an acoustic issue of annoyance associated with turbines, but the emphasis should be on low frequency noise. In Leventhall's DEFRA report, in 2004, he referenced work undertaken by Bradley in 1994 that changed the modulation rate of low frequency noise and obtained a subjective assessment of the annoyance factor for different rates of modulation. Bradley indicated for the critical region of between 2 and 4 Hz (being the rate of modulation of low-frequency noise) could require an adjustment for annoyance of up to 17 dB, due to the subjective assessment of the severity of the annoyance when compared to no modulation. Leventhall reportedly "left" this mainstream of thought in 2005 as he became the primary Wind Energy acoustical spokesman.

The level of annoyance suffering increases substantially for low frequency sound - once perceived - than the more readily audible mid-frequency sounds. Low-frequency is in the 20-200 Hz range and is more appropriately measured with dBC filtering.

### **Annoyance:**

A complex consequence of IWT... will focus on "audible" sources. (Taken from Rick James, 2009)

It is not clear which of the following IWT noises generate "annoyance suffering" that is specified by the WHO as an "adverse health effect". It could be:

- 1) the distinctive rhythmic, impulsive or modulating character of wind turbine noise (synonyms for "thump", "swoosh" or "beating" sounds.
- 2) its characteristic low frequency energy (both audible and inaudible and also impulsive),
- 3) health effects of chronic exposure to wind turbine noise (especially at night),
- 4) in-phase modulation among several turbines in a wind farm (this can triple the impulse sound level when impulses of three or more turbines become synchronized)

or some combination of all these factors best explains the annoyance. One or more of these characteristics are likely present depending on atmospheric and topographic conditions, (especially at night) as is the individual susceptibility of each person to them.

Nevertheless, reports based on surveys of those living near wind farms consistently find that, compared to surveys of those living near other sources of industrial noise, annoyance (suffering) is significantly



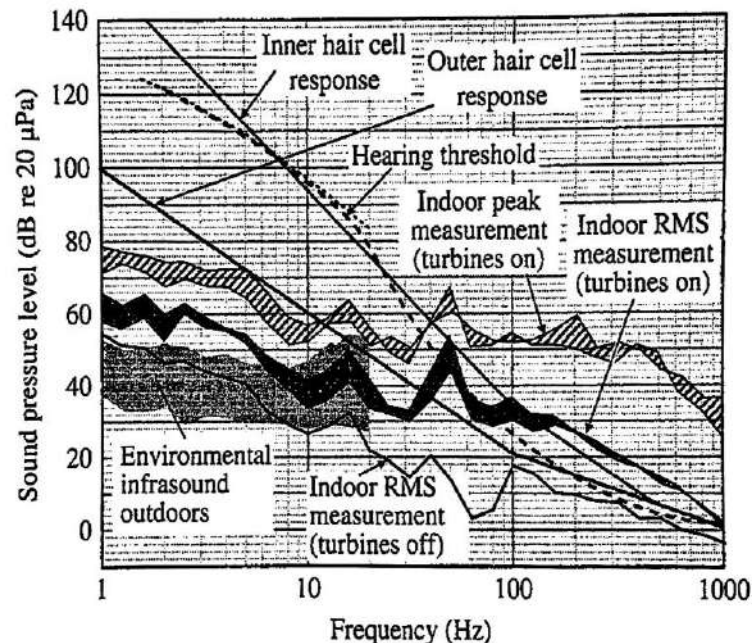
higher for comparable sound levels among wind utility footprint residents. In most cases, where relationships between sound level and annoyance have been determined, annoyance starts at sound levels **10 dBA or more below the sound level** that would cause equivalent annoyance from the other common community noise sources. Whereas one would expect that people would be annoyed by 45 dBA nighttime sound levels outside their homes in an urban area, rural residents are equally annoyed by wind turbines when the sound levels are 35 dBA independent of the time of day.

Annoyance is discussed later to a greater extent in the discussion of adverse health effects.

## Appendix

(Taken from the "Wind farm Noise" textbook during the author's description of Outer Hair Cell Responses, Hearing Thresholds in the Infrasound and Lower-Frequency Sound Spectrums)

Note significantly lower recognition of infrasound emissions as perceived by the "outer hair cell response".



**Figure 7.7** Inner and outer hair cell responses, hearing thresholds, environmental infrasound and wind farm infrasound.

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Part – 5: History

**Wind Energy's Wind Ordinance preferences: Where did they come from and will they protect human health?**

In this section I will review first the early understanding of lower frequency noise and its impacts on humans and then focus on the development by Wind Energy of the ETSU-R-97 guideline document that has come to be the "basis and explanation" of current siting of IWTs at a typical distance of 1500 feet from residences despite a tremendous amount of recent science saying that adverse health effects are seen at that distance.

**Early ILFN recognition in Industrial gas turbines and HVAC systems.**

(Taken from Richard James review article: "Wind Turbine and Low-Frequency Sound: Warning Signs That Were Not Heart) - Bulletin of Science, Technology and Society 32(2) 108-127, 2012)

In the 1970s through the 1990s, acoustical consulting was often associated with occupational and community noise in the audible frequency range. Several projects involved industrial processes where high levels of infrasound were a significant factor contributing to an occupational hazard. Examples of locations where workers reported adverse audible and ILFN included foundries operations and combustion burners. In the early 1990s, there were concerns about pregnant women being exposed to noisy occupational environments.

James, in his article, pointed out that the ILFN was not the focus of the study but did prompt changes to the noise processes to allow greater worker safety and tolerance. This author importantly makes the distinction that unlike those industry responses, Wind Energy has not pursued any investigation of the sound types nor impacts of the noise made by IWTs. While some IWT design changes were made (use of up-wind design, blade shape/wind loading considerations, and blade edge "feathering" - that mostly affect audible noise emissions), ILFN cannot be appreciably lessened **except by** reduction in the sound power level ratings of the turbines and/or by increasing distancing to the receptor (resident).

By the early-mid 2000's, increasing numbers of reports of resident AHEs living near wind turbine utilities were appearing, which this author believes was related to:

- 1) intense ramp-up of on-shore IWT farms in this country - moving from remote locations into rural residential areas.
- 2) a substantial increase in the power generation capacity of individual turbines (correlated with "blade swept area" made possible by added turbine hub height to permit longer blade arm lengths and technologic improvements in turbine design and building materials, (all done without ANY acknowledgement nor study of potential subsequent heightened AHEs to humans).
- 3) implementation of turbine-siting guidance with "Outside U.S."- developed "turbine siting guidance" (mostly through the ETSU-R-97 document developed by Wind Energy interest in the United Kingdom in the absence federal oversight/verification in this country).

Over those early years, a number of acoustical engineer researchers collected an increasing body of knowledge focused on the similarity of machinery - produced and IWT - associated worker/resident complaints. James mentioned Charles Ebbing - head of Carrier Corp Acoustical Labs who investigated HVAC noise affecting some occupants of high-rise office buildings. Dr. Malcolm Swinbanks, who had many years of experience with machines that produce ILFN, was an early investigator. He also had personal experience with inaudible levels of modulated ILFN causing the type of symptoms associated with IWTs. Dr. Swinbanks became a major scientist raising the concern of AHEs caused by IWT noise emissions.

Of particular historical clarification, is that Dr. Swinbanks worked from 1975 to 1978 and then again from 1985 to 1989 with Dr. Geoff Leventhall on these investigations of noise production by gas turbines and industrial wind turbines. Indeed, clarification of the ILFN emissions from IWTs was made by Kelley, et al in the 1980s, with a decade-later reaffirmation of the relevance of that work in the understanding of adverse health effects from those lower frequency noises.

It is of absolute importance was that Dr. Geoff Leventhall did much of the research needed to resolve the problem. A report published in 1997 by some of the same researchers who have since published articles on wind turbine noise and other effects (Persson Waye, Rylander, Benton, and Leventhall) highlight some of the compelling parallels:

1) (From the background): Some of the symptoms that are related to exposure to low frequency noise such as mental tiredness, lack of concentration and headache related symptoms, could be associated with a reduced performance and work satisfaction.

2) (From the Conclusion): The results showed that low frequency noise was estimated to interfere more strongly with performance. The results also gave some indications that cognitive demands were less well coped with under the low frequency noise condition. .... The relation between reduced activity and response time, which was especially pronounced in the low frequency noise condition, may also indicate that increased fatigue was of importance for the results.

The adverse health effects reported by workers occurred with short-duration exposure (e.g. 8 hours a day or less). This is a much lower "dose" than what people living near IWTs experience. That 1997 study found that some of the symptoms related to exposure to modulated very low-frequency sound are similar to those reported by people experiencing exposure to IWTs.

Rick James went on to highlight other, earlier parallels in scientific evaluations of "noise-Induced sick building syndrome. This referred to buildings erected during the 1970s and 1980s that used large fans, centrally located, often on the top floor, to provide heating and air-conditioning for the building. In the affected buildings, complaints arose that people did not want to live or work there. Complaints of physical discomfort, productivity loss, effects on mood, lower social orientation, cognitive dysfunction, headaches were voiced by many (but not all). In these buildings, it was found that the HVAC system was the primary source of recorded infrasound and very low-frequency sound. Not all workers in the building complained of audible rumbles. When the problem was audible, one or more workers might

hear a rumble or roar from the ventilation ducts. In those cases, there was little question about the problem. People who could hear it, demanded that it be fixed. But, if it was inaudible, people did not associate their symptoms with the sounds that made them less productive. It required special studies and tests developed by Dr. Leventhal and others to identify that the workers' sense of being uncomfortable or having other symptoms while in their offices was associated with the modulated ILFN. These investigators convincingly showed that pulsations in the HVAC systems corresponded to times when the workers reported symptoms of mental tiredness, lack of concentration, headaches and reduced performance and work satisfaction. Rick James carefully and fairly clarified that many of those symptoms from the studied "sick buildings" were "couched" in the language of productivity and work performance. However, subsequent research revealed a host of closely-matched symptoms that are reported by those experiencing adverse health effects from IWTs.

Apparently, Dr. Leventhall, despite his early research and clarification of ILFN being responsible for symptoms closely mirroring those from IWTs, in the years to follow, uniquely and inexplicably chose to develop and support Wind Energy's stance on the "benign" character of ILFN produced by wind turbines. He became a champion and referenced leader in Wind Energy's promulgation of IWTs around the world.

#### **Hearing vs Perceiving - Both can produce AHEs**

Continued research supported the link between the complaints and aspects of wind turbine ILFN. People who worked or lived near large rotating machines found that they felt uncomfortable or had symptoms that were not related to any known illness or pathology. A common denominator of all those machines is that they produce sounds in the ILFN range. A review of some studies conducted to determine why people reacted negatively to working near these machines revealed a "common thread" - inaudible ILFN was present and was associated with the physical symptoms reported by some of the workers.

Previous research had shown that at AUDIBLE levels, ILFN were able to produce physical responses. However, many scientist and engineers assumed that inaudible levels could not cause any problems. Indeed, Mid-American Energy (MAE) representatives in our Winterset Courthouse during the 2018 permitting process, repeated the saying "what you can't hear, can't hurt you". Many acoustical engineers were taught this as a part of their academic training regarding the perception of ILFN. Subsequent studies by researchers such as Swinbanks, Ebbing and Ebbing's colleague Blazier, an independent acoustical consultant who worked in the HVAC industry, found evidence that SOME people responded to INAUDIBLE levels of ILFN produced by the machines.

Further, relevant comments by Swinbanks (2010) include "as a result of spending long hours working on sites in the presence of significant levels of very low frequency noise, I acquired considerable familiarity with its effects and consequences." In addition, and not unique to just Dr. Swinbanks, he became

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sensitized to ILFN his early work with those noise exposures, noting he could perceive or "feel" inaudible ILFN. This author has, as well, appreciated that ineffable sensation (best described as an extremely fine skin tingling) when emerging from a car in the setting of densely and closely sited large IWTs surround a home in central Adair County operating during "heavy winds," to attend a meeting.

Typically, when a resident complains of "perceiving" these "inaudible pulsations", an industry-paid acoustician may come to measure nearby IWT emissions. Their reports state that the levels of infrasound are below the threshold of perception for steady pure tones. Swinbanks (2010) stated "care must be taken when comparing broad-band measurements, having noise simultaneously present at all frequencies, against a threshold defined by individual, stand-alone pure tones". He offered a neuro-processing basis observation: When an ear is subjected to a steady pure tone in a laboratory environment, it will be less sensitive to low-frequency sound than when presented with sound consisting of a complex mix of tones (neither steady nor pure) in the same frequency range. They are a complex mix of tones whose summed amplitude modulates in short, rapid bursts, sometimes lasting 10 milliseconds or less. These modulations, or pulsations have high crest factors and large dynamic ranges. The peaks can be 30 to 40 dB higher than the SPL (sound pressure level) in the valleys between them".

Dr. Malcolm A. Swinbanks produced a nice review of this topic when presenting to the Australian Senate Select Committee on Wind Turbines on March 20, 2015. Part 2 describes "The Perception of Low Frequency Sound and Infrasound". As noted in the previous paragraph, it is important to see IWT noise as "impulsive and complex".... meaning levels of sound fail to take into account either of the character of the sound or the relationship between adjacent frequency bands. He also referenced a number of reported cases in the literature where ILFN was clearly being perceived at significantly lower levels than would be assessed by such basic comparisons with the hearing threshold.

He summarized that "conventional hearing perception is considered to take place via response of the inner hair cells of the cochlea (the sensing structure of the inner ear), but it has been shown that the cochlea outer hair cells respond with greater sensitivity at very low frequency, and induce additional neurological signals. Hitherto, these outer hair cells have been considered to perform only the task of controlling the overall sensitivity of the hearing process, but it is possible that they can also contribute directly to very low frequency perception". He continued with "a further mechanism has been proposed, whereby sound pressures acting through the lymphatic fluid directly on the otolith components of the vestibular (balance) organs have been calculated to exert comparable forces to those induced by motion and acceleration. Any non-uniformity in the compliance of the structures supporting these otolith sensors may then result in a response which that of physical motion. Indeed, it has been argued that the correlation between persons who suffer from motion sickness and those who report adverse effects from wind turbines is sufficient to be more than a result of mere chance". Of note is that a resident from NW Madison County, who turned west onto I-80 was faced by a horizon of revolving turbine blades. She soon thereafter felt sick, nauseated and vertiginous enough to be forced to stop her car on the side, attempted to recover, fortunately later then proceeded off the next exit.... eventually recovering upon exiting the turbine field. That same sensation has been noted by others.

### Wind Energy Concedes "Annoyance" Exists but Offers Other Excuses

Over the past twenty years, the wind industry has presented "their" evidence implying that IWTs are "safe" near people's home. Yet the reports of nearby residents suffering annoyance, sleep disturbance and the consequences of chronic non-restorative sleep and body/vestibular responses have been received from people living within 2 or more kilometers of IWTs not only located in this country but in countries around the world (Hanning & Nissenbaum, 2011; Harry, 2007; Krogh, Gillis & Kouwen, 2011; Nissenbaum, 2009; Phipps, Amati, McCoard and Fisher, 2007; Shepherd, McBride, Welch, Dirks & Hill, 2011).

Some of the research has focused on the annoyance potential from audible sound produced by wind turbines. Wind Energy agrees that annoyance does exist but stops there to accept the impact of that adverse consequence. Annoyance suffering is real and is an adverse health effect in and of itself - as was recognized and stated clearly by the WHO in 2009. Symptoms of depression, anxiety, confusion, vertigo (among many, many others) are real spin-off manifestations of being in close proximity to these turbine towers. They are NOT reflective of psychosomatic or psychological illness of residents. The "nocebo effect" may have some minor role but as months to years of exposure pass, the symptoms frequently persist and may become debilitating making a psychosomatic etiology highly unlikely. I would point out that the 2015 peer-reviewed publication by the Council of Canadian Academies that was given to the Madison County Board of Health by the Iowa Environmental Council (local representation of the Wind Energy faction) lists that current evidence is sufficient to establish a causal relationship between a person's exposure to wind turbine noise and feelings (suffering) of annoyance.

Beyond the audible and visible "triggers" of annoyance suffering there are less obvious causes of the adverse health effects from IWTs. While Wind Energy has repeatedly downplayed the concern of infrasound and that humans are biologically incapable of "hearing" infrasound so that it should represent no concern to human health, there is ample evidence that this is **not** the case.

- 1) There are examples of adverse health responses mediated through the vestibular system's response to modulated infra and low-frequency noise.
- 2) Salt and Lichtenhan (2011) and Salt and Kaltenback (2011) have confirmed that there is a physiologic response to modulated infrasound at levels below the threshold of perception (defined in laboratories using "pure tones" that may start at amplitudes as low as 60 dBG).
- 3) Swinbanks (2011) demonstrated that as a direct consequence of the dynamic time domain stimulation of the auditory system by the modulating wind turbine infrasound, the "typical IWT infrasonic and low-frequency noise can be readily perceptible and audible at very much lower levels than had been previously recognized" (noted above).
- 4) Even much more recently, (Max Planck Institute) data using f-MRI (functional magnetic resonance imaging of the brain), found that "subaudible" noise in the infrasound range directly "activates" specific

brain centers or "nuclei" which are known to directly influence body autonomic responses. In my opinion, this may be the link with automobile and air traffic noise where autonomic stimulation is thought to trigger the development of cardiovascular disease. This is very likely the case with IWT noise but, because IWT noise is more "annoying", this autonomic triggering is likely beginning at lower sound thresholds (less loud) than the other studied environmental noises. These threshold comparisons are shown in the 2018 WHO report.

Despite these findings and clear impacts of adverse health effects on humans by IWTs, the Wind Energy Industry, through its experts and trade associations, has denied that IWTs can cause such AHEs.

Highly recognized experts, some well-known in the field of acoustics, have defended the wind industry position through white papers, reports and testimony in hearing and through committees that establish guidelines for siting industrial-scale wind turbines. That viewpoint has not been accepted by other experts.

### **NASA and Department of Energy Funded Research from the early 1980s to about 1991**

The U.S. government has known about health effects of infrasound and low frequency noise from IWTs since 1987. It was concerned (then) enough to commission a study. The study was a research project funded by the U.S. Department of Health, Contract No. DE-AC02-83CH10093. Among many impressive scientific papers, was the following: Dr. N.D. Kelley, Solar Energy Research Institute, Golden, Colorado: "A proposed Metric for Assessing the Potential of Community Annoyance from Wind Turbine Low-Frequency Noise Emissions" Note: "Community Annoyance" is now called Wind Turbine Syndrome; "Low Frequency" includes infrasound; "Emissions" includes noise and vibrations.

It should be noted that the Wind Energy faction still does not (implied refuses) to consider to measure ILFN exposure levels inside the home.

**Between 1982 and 1988, Kelley and his colleagues published five important papers: 1. N. D. Kelley, R. R. Hemphill, M. E. McKenna. "A Methodology for Assessment of Wind Turbine Noise Generation", 1982. (First published in J. Solar Engineering, Vol. 21 (1981), pp.341-356). 2. E. W. Jacobs, N. D. Kelley, H. E. McKenna, N. J. Birkenheuer. "Wake Characteristics of the MOD-2 Wind Turbine at Medicine Bow, Wyoming". November 1984. 3. N. D. Kelley, H. E. McKenna, R. R. Hemphill, C. I. Etter, R. I. Garrelts, N. C. Linn. "Acoustic Noise Associated with the MOD-1 Wind Turbine: Its Source, Impact, and Control". February 1985. (First published by the Solar Energy Research Institute, February 1985). (262 pages) 4. N.D. Kelley. "A Proposed Metric for Assessing the Potential of Community Annoyance from Wind Turbine Low-Frequency Noise Emissions", November 1987. 5. N. D. Kelley, H. E. McKenna, E. W. Jacobs, R. R. Hemphill, J. Birkenheuer. "The MOD-2 Wind Turbine: Aeroacoustical Noise Sources, Emissions, and Potential Impact". Solar Energy Research Institute. Prepared for the U.S. Department of Energy, January 1988. His work was published in peer reviewed journals. He presented his paper "Acoustic Noise Associated with the MOD-1 Wind Turbine: Its Source, Impact, and Control" at the Fourth ASME (American Society of Mechanical Engineers) Wind Energy Symposium held in Dallas, Texas on 18-20 February 1985. In 1987 he presented his paper "A Proposed Metric for Assessing the**

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**Potential of Community Annoyance from Wind Turbine Low-Frequency Noise Emissions", at the American Wind Energy Association "Windpower '87 Conference and Exposition", October 5-8, 1987 in San Francisco, California.**

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Kelley et al, concluded: "...one of major causal agents responsible for the annoyance of nearby residents by wind turbine noise is the excitation of highly resonant structural and air volume modes by the coherent, low frequency sound radiated by large wind turbines. Further, there is evidence that the strong resonances found in the acoustic pressure field within rooms actually measured indicates a coupling of subaudible energy to human body resonances at 5,12 and 17-25 Hz, resulting in a sensation of whole-body vibration." A page from that publication graphically shows the display of measured frequencies and their sound pressures.

3) Additional investigation by Kelley, found that turbines radiated their **peak** sound power in the infrasound range, typically between 1 and 10 Hz (that is STILL the case as can be seen on Wind Industry produced displays of IWT-produced sound intensities along the entire noise spectrum). Annoyance was the result of a coupling of the turbine's impulsive low-frequency acoustic energy into the structures of the home and that the annoyance was frequently confined to "within the home itself". In Kelley's and in three other investigator's work, the studies report similar findings, namely that perception, generally is non-auditory in character, begins when the rms ("average") SPLs (loudness) of the modulating tones that are as low as 35 dB rms with increasing impacts as the rms levels rise to 50, 60 and to 70 dB and higher. In all these studies the dynamic modulation of the blade-pass tones produces pressure peaks that are often 10 dB or more greater sometimes much more, than the rms values.

The following link tracks the work of Dr. Kelley and his findings which remain relevant for IWTs currently being placed for energy generation.

<http://docs.wind-watch.org/Infrasound-wind-turbines-4-August-2015.pdf>

**I would strongly recommend that this link be opened and the history of the recognition of infrasound and its potential for adverse health effects was first described by N.D. Kelley and how it was "forgotten or intentionally overlooked". Despite the recognition of potential human harm, this information was discarded by Wind Energy and specifically by the turbine manufacturer, Vestas, the manufacturer of turbines proposed for installation in Madison County.**

Two primary researchers, Hubbard and Shepherd (1990) (**30 years ago**), reported the following:

- 1) Wind turbines primarily produce infrasound and low-frequency sound.
- 2) Sound propagates from IWTs at a decay rate half that of common (audible) "point" sources
- 3) IWT noise travels farther than other sounds.
- 4) IWT noise will be a significant indoor noise problem due to room resonance and a dominance of ILFN acoustic energy.



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**1500 Setback recommended by MAE:**

Fifteen hundred (1500) feet was the distance (in the original Mid-American Energy (MAE) request for siting of IWT) from rural residences for the proposed Arbor Hills Wind Farm. At none of those initial and none of the subsequent follow-up meetings at any level was there a description of how that distance was proposed, how long it had been in use nor ANY description about the human health implications of that distance. In the written proposal, there was no listing of the anticipated noise exposure level to residents. Some of the presenting MAE representatives were not clear as to which model of IWT was planned for Arbor Hills. The only mention of noise levels incurred by the IWTs was the verbal (never written) comment (during the meeting) by Matt Ott (MAE) was that he anticipated no more than 45 decibels at the front door of an occupied residence. He claimed that it was a safe level. Fifteen hundred feet setback was the only specification in not only Madison County's proposals but also that of Adair County and any proposal IWTs that I have seen for Iowa. So where did it come from?

**The Origen of the 1500 Foot Setback**

Industrial Wind Turbines function through transferring wind energy onto large rotating blades that turn a shaft that operates a generator that creates electrical energy. That entire string of energy transfer creates sound which is characterized as "noise" when it is characterized as disagreeable. Noise regulation from any source in the United Kingdom was via the British Standard BS4142 (described as method for rating industrial noise affecting mixed residential and industrial areas). A document described as the Planning Policy Guidance 24 (PPG24) was generated in the UK that outlines some of the main considerations which local planning authorities should take into account in drawing up development plan policies and when determining planning applications. PPG24 provides advice on how the planning system can be used to minimize the adverse impact of noise without placing unreasonable restrictions on development or adding unduly to the costs and administrative burdens of business. The document introduced the concept of noise exposure categories (NECs) ranging from A-D for residential development and recommends appropriate levels for exposure to different sources of noise. A proposal for residential development needed a determination of which NEC categories would be operative also taking into account both day and night-time noise levels. The PPG24 takes into account the recommendations of the Noise Review Working Party which reported in October 1990.

PPG24 - 1994 recommended using the British Standard BS4142. This regulation was formulated to assess facility external noise (outside at a property) **based on the likelihood of complaints**. Background noise levels (LA90) should be measured. Source-specific noise levels (rating level) are then obtained from manufacturer's data or measured in situ. The background noise level is then subtracted from the Rating Level. If there is likely to be a tonal content or "specific character" to the building services plant noise then a +5 dBA correction is applied to the Rating Level. This assessment method is only applicable to external areas. Assessment of excess value:

- 1) A difference of around +10 dBA or more indicates that complaints are likely
- 2) A difference of around +5 dBA indicates a marginal significance of complaint.

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This is the same (but not for IWTs) formulation as used in the United States ... as in the ISO TC/43.

((ISO is the registered trademark for the International Organization for Standardization. TC/43 deals with acoustics under which there are three subcategories - noise, building acoustics and underwater acoustics. Under the "noise" category, there are many further subcategories including ISO 1996-1:2016 which describes measurement and assessment of environmental noise. In the overview of subcategory, ISO 1996-1:2016 defines the basic quantities to be used for the description of noise in community environments and describes basic assessment procedures. It also specifies methods to assess environmental noise and gives guidance on predicting the potential annoyance response of a community to long-term exposure from various types of environmental noises. ISO 2016 is currently in the third edition, is 47 pages long, and can be purchased from the ISO website)).

In general, the LA90 (background) noise is going to be in the mid-upper 20s dBA range in the rural residential areas of Madison County.

This BS4142 regulatory limit is based on reasonable likelihood of complaint generations and was too restrictive for IWTs **as wind turbine have no noise control options except greater distancing**. Other industrial facilities don't have this problem, because they can enclose machinery in buildings, use mufflers, duct wrapping, etc. Thus, the Wind Industry had to come up with a "guideline" that raised background noise levels with the definition of 'LA90 -10 min' and convince U.K. regulators to use that guideline instead of BS4142. (Unfortunately, the LA90-10min measurement is effective for broadband noise such as traffic noise but not when measuring intermittent noise as produced by wind turbines). That is exactly what they did as they developed ETSU-97. BS4142 continues to be used for industrial permitting and apparently remains a thorn in the side of consultants working to permit wind turbines and promote more noise in rural areas.

### **ETSU-R-97**

ETSU-97 is a guideline and not a set of regulations. The acronym stands for "Energy Technology Support Unit". The ETSU working group was formed by the British Wind Energy Association for the purpose of preparing wind energy friendly guidelines and research. In that capacity, it worked on behalf of the Department of Trade and Industry (DTI); generally, with no independent oversight and no transparency. "The Assessment and Rating of Noise from Wind Farms" was published in 1997 and became and remains the UK government's preferred method of assessing wind farm noise for planning purposes. Rick James (in his article, Wind Turbine Infra and Low-Frequency Sound: Warning Signs that were not Heard) went on to describe the "inadequate" design of the ETSU-R-97 which was a "guideline only" for the UK that was developed specifically to circumvent more science-based UK regulations that were more restrictive to IWT placement. The guideline was developed by the Working Group on Noise from Wind Turbines which consisted of several acoustical consultants with ties to the wind industry in the UK, representative of companies or their attorneys involved in or with the wind industry, and several representatives of local governments and the chairman, who represented the government's Department of Trade and Industry (DTI).

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The introductory comments about ETSU's purpose to "offer a reasonable degree of protection to wind farm neighbors without unreasonable restriction on wind farm development" has been met with near universal contempt (as also occurred in Madison County during a joint writing session with the Supervisors) as the guidelines should not provide the justification to impose greater levels of wind turbine noise intrusion than would be permitted by other forms of industrial development.

ETSU-97 compares the turbine noise with a level 5dB above background noise, but when background noise levels are low (particularly in rural areas), it sets a higher lower limit. The day time lower limit can be anywhere between 35 and 40 dBA and the night time lower limit is 43dBA. The most bizarre result is that night time background noise level can be "assigned" up to 8dBA more than the day time noise. No other standard anywhere in the world has a nighttime limit higher than a day time limit. The ETSU-R-97 was specifically designed that way to harvest the greater wind resources that occur at night.

It appears that the ETSU-R-97 was produced to permit introduction of wind farms into inappropriate low background noise locations where they and other comparable industrial installations could not meet planning conditions derived from the long established BS4142. It could be reasonably supported that the Department of Trade and Industry (DTI) worked with the British Wind Energy Association that formed the ETSU to develop "fuzzy-science" based guidelines. I would view this as "pseudo-science to support policy, NOT policy to support science".

Further concerns:

- ETSU-97 is a document that has remained unchanged over 23 years. Over the same period most everything else has changed:

- 1) The understanding into the effects of noise on people has advanced - particularly regarding adverse effects of noise on sleep and potential for cardiovascular disease promotion from environmental noise. The World Health Organization has weighed in with guidelines concerning not only other forms of environmental noise but also IWT noise. Sleep studies and actigraphy (movement) monitoring have now clarified sound pressure levels where there is 1) no sleep disturbance, 2) non-conscious recognition of noise with subsequent disturbance of healthy sleep stage architecture and 3) awakening from sleep due to the uniquely disruptive quality of IWT noise.
- 2) The maximum size of IWTs has increased. With that, adverse health effects from sound emissions in the infrasound-low frequency noise (ILFN) range are now recognized in turbines >.5 MW thus creating new health considerations of turbine siting (that were not considered with the initial guideline).
- 3) The maximum size of wind farms has increased.
- 4) The possibility for closer adjacencies between neighboring wind farms has increased, leading to the need for greater consideration of cumulative noise effects.
- 5) The approach to wind turbine control has evolved from previously dominant 'stall regulated'

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technology to the now dominant 'variable speed' technology, thereby enabling much more control flexibility over the noise output characteristics of wind turbines.

6) Acoustic standards which were present in the early 1990s (which then formed the basis of discussions for ETSU-97) have been updated. This includes increased awareness of factors affecting 'derived prevailing background noise levels'.

Despite all these technologic and scientific advances in our understanding of IWT noise and its effects on human, the ETSU-97 has not changed since it has been accepted as non-regulatory guidance.

1) They initiated the "practice" of unreasonably "treading" inside the property rather than sticking to the property line.

2) ETSU-97 avoids "sound limits", rather, they set up the device of "relative to background noise: with which they were able to ramp the limit up assuming a low wind shear (gradient of wind speeds over the vertical height of the rotor sweep) factor. Noise intrusion is most likely during high wind shear conditions so mainly during the night time and evening when wind speeds at ground level are likely to be low but turbine noise at or close to maximum. Noise assessments by wind farm developers have either failed to consider wind shear or applied very low levels of corrections so underestimating the likely noise impact on nearby residents.

3) Additionally, when ETSU-97 was written, the tallest IWT was 32 meters to the hub, at which height wind shear effects could only lend to relatively small errors. Now total heights of tower/blade are >200 meters bring even greater adverse wind shear associated noise production. On average, high wind shear occurs at night about one-third of the time.

4) ETSU-R-97 allows night-time IWT levels to >20dBA above actual background noise in many quiet rural locations. (Greater than 10 dBA over background levels is associated with noise levels where complaints are likely. The additional 10 dBA represents noise levels that are 4 times louder and 100 times more intense)

5) They used a L90 (average over 90% of time tested) for the wind turbine noise, which is approximately 7-13 dB lower than the Lmax. Sleep disturbance, being biologic in origin is best characterized at given decibel threshold levels. ETSU-97, by characterizing noise essentially as an average (Leq), eliminated any possibility of assessing for sleep disturbance which is the most important of the many adverse health effects produced by IWTs. The "Leq" noise level designation of the IWT noise level (rather than Lmax) continues today and is present in the Wind Ordinance draft given (directly or indirectly) to county supervisors by industry.

6) There is no recognition of infrasound, low frequency (ILFN) or tonal noise character (see below).

7) Amplitude modulation is the most important noise characteristic of wind turbines. All comments about this are excluded in ETSU-R-97. Wind turbine excess amplitude modulation (EAM) is generally recognized as when the turbine blade 'swish' changes to thumping or banging. EAM is highly intrusive

event at >1.5 km. The attenuation afforded by a closed window can be highly variable depending on the type of glazing system and frequency of the noise. In the event of low frequency noise as occurs with EAM, no window type, whether open or closed is effective at attenuating the noise. EAM is similar to helicopter "blade slap" - itself the result of blade vortex interaction. This aerodynamic interaction noise consequence has been well understood for decades... Why is a wind turbine's EAM such a technical mystery for Wind Energy? Simple: Wind Energy (including Mid-American Energy - as overtly stated by Matt Ott - one of their apparent technical experts) denies that ILFN can be perceived in any way by humans and therefore could not cause no adverse health effects. Vestas, the manufacturer of IWTs used by MAE in this region, formally requested and received permission from New South Wales, Australia 2012 to longer consider ILFN a relevant consideration in IWT siting. It appears that Wind energy has continued the same stance to completely ignore ILFN as a concern in this county (in the absence of federal/state oversight). A complete copy of that letter is in this part's appendix.

This description is NOT to suggest that the labeled ETSU guidelines are the ones specifically given to the Supervisors nor were incorporated into the initial MAE request for variance. The distance "1500 feet" is used throughout Iowa and the only precedence for this "extremely close setback and consequential excessive resident noise level exposures came with the development and initial acceptance by the UK government. The "forced acceptance" by residents outside the U.S. has appeared to have worked well enough that WE development in this country has simply retained those original poorly conceived and now further outdated "guidelines". Peak noise levels appear arbitrary as well. At every location within the UK or where ETSU principles have been used internationally there has been resistance and public outcry in not all but among a significant proportion of affected residents.

### **Subsequent Adoption Worldwide**

After being adopted (but not approved as regulation) by the British government, British Acousticians Hayes and later Leventhall were pivotal in the adoption of the ETSU-R-97 tenets - particularly to former British colonies (Australia, New Zealand) - with these Acousticians being presumably sent to establish control of the narrative and establish a template that the local firms could subsequently use for other wind energy projects. Leventhall formally started his pro-Wind energy work when he became a spokesperson for the British Wind Energy Association in the mid 2000's after Dr. Van den Berg published his thesis "The Sound of High Winds" and two other papers that observed wind turbine blades create pressure pulses as the blade passes the tower. For the next 15 years, reportedly at the request of industry trade groups, Leventhall and others organized "international" wind turbine noise conferences where research was promoted and reviewed that reflected the Wind Energy vision. Hayes (British Acoustician) apparently consulted on a project in New York state in the mid-late 2000's where working with US consultants reportedly "borrowed ETSU concepts" to get their projects approved in later projects. Those "templates" reportedly initiated by Hayes were "used around the world" being changed to accommodate regulations. It is highly likely that such "original" language perpetuates to this day; with the various "Wind Energy Associations" sharing the recipe to Wind Energy Industry (contractors)- a great many of whom sit at the Wind Energy boards. (Do a search for the Australian senate's hearings

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on wind turbine noise. Start at "Stopthesethings.com" and "the Waubra Foundation" searching for the names Hayes, Leventhal, Swinbanks, Thorne, Cooper to locate their work in Australia and New Zealand).

### **So Where is the Federal-Level Oversight to Protect the American People from IWT Adverse Health Effects?**

Aaron Price (Madison County Supervisor – resigned as of early July, 2020) stated in a prior county meeting something to the effect that the Federal government would not have allowed IWTs to become so "widespread" if there was some inherent risk to human health. The unspoken fact is: There is **NO** regulation of IWT by the U.S. Federal government. This fact, in the course of my reading, remains completely unaddressed by Wind Energy; they get to define if IWTs are safe (seemingly in an arbitrary and capricious manner) or not and convince local counties in Iowa that they are OK. They have found that financial incentives seem to facilitate adoption of IWT placement - both for the landowners and the county tax rolls.

The U.S. Environmental Protection Agency (EPA) created the Office of Noise Abatement and Control (ONAC) following enactment of the Noise Control Act of 1972. In 1981 Congress agreed to the Reagan Administration's proposal to cease funding for ONAC. Congress, however, did not repeal the Noise Control Act when it eliminated ONAC's funding.

Before its elimination, ONAC engaged in a wide variety of activities to abate noise pollution under authority of the Noise Control Act and, after 1978, the Quiet Communities Act.

The Quiet Communities Act of 1978 amended portions of the 1972 Noise Control Act to require coordination between federal agencies on noise control. It was intended to speed up FAA response to noise regulations proposed by the EPA and requires the FAA to provide the public with a detailed analysis of EPA proposals. These included identifying sources of noise for regulation, promulgating noise emission standards, coordinating federal noise research and noise abatement, working with industry and international, state and local regulators to develop consensus standards, disseminating information and educational materials and sponsoring research concerning the effects of noise and the methods by which it can be abated. It also authorized the EPA to provide grants to state and local governments for noise abatement.

The EPA ceased most noise abatement activities after ONAC's funding was eliminated. There is still some minimal enforcement in the area of airport noise. Responsibility for the enforcement of EPA's railroad and motor carrier emission standards was shifted to the Department of Transportation.

Since defunding ONAC, federal noise emission and labeling standards have not been subjected (best I can find in the internet literature) to critical evaluations despite the evolution of relevant science and technology and a better understanding of the effects of noise on people. The EPA has been unable to provide technical assistance to state and local governments or to participate in private standard-setting efforts. State and local governments have been preempted from adopting their own noise emission and labeling standards that differ from EPA standards for sources or products that EPA has regulated. Apparently, there were **never** any EPA standards or regulations for industrial wind turbines. State and

local governance has had to pick up that protective effort... but as said many times... without funding or other vital resources to do that. Specifically lacking are technical resources and highly trained engineering specialists to understand the science of industrial wind turbine sound emissions and interpret and stay current with the rapid explosion of our understanding of those sound emissions causing adverse health effects. Unfortunately, relying on Wind Energy and the Wind industry for objective knowledge and guidance in protecting human health has never happened. In my opinion, executing their agenda has, by necessity, eliminated their concerns of protecting human health.

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Part 6: Adverse Health Effects from IWTs

A great review (essentially a textbook - 2014) was done by Bob Thorne, PhD (PhD in Public Health and Acoustician specializing in infra- and low frequency sound) - 158 pages "Wind Farm Noise and Human Perception - A Review". (May google the title; the entire text comes up). It starts with the Preamble: "There is a significant body of peer-reviewed research readily available in public forum to substantiate the potential for serious to moderate adverse health effects to individuals due to wind farm activity noise while living in their residencies and while working on their farms near large-scale wind farms or large turbines. Adverse health effects can arise from extreme psychological stress from environmental noise, particularly low frequency noise with symptoms of sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic attack episodes associated with such sensations when awake or asleep".

The hypothesis from this Review is that serious harm to health occurs when a susceptible individual is so beset by the noise in question that he or she suffers recurring sleep disturbance, anxiety and stress. Research for the Review suggests that 5% to 10% of the individuals living in the vicinity of a large wind farm will experience serious harm to their health. The observed markers for serious health effects are:

- (a) wind farm noise levels of LAeq 32 dB or more **OUTSIDE** the residence and
- (b) wind farm noise if heard or is perceptible (felt) at levels above the individual's threshold of hearing **inside the home**.

Previously, a study took place in Victoria, Australia (2012) that was led by Bob Thorne that was published and presented to the Australian Senate Hearing on 'Excessive Noise from Wind Farms'. The residents interviewed lived between 700 and 3500 meters with an average distance of 1400 meters. (This is almost three times farther than the distance proposed by Mr. Clifton in his Wind Ordinance draft submitted to the Board of Zoning for review and judgement). The study design is exploratory and observational, establishing the research required for the development of hypotheses. It is a scientific-method-driven determination of health-related, perceptual and environmental variables, i.e. health-related quality of life and noise exposure in a sample of adults exposed to wind farm generated noise.

The study used convenience sampling to obtain completed questionnaires. The survey included self-report assessments on exposure to community noise and perceived intrusiveness of noise; annoyance and sleep interference due to noise exposure; psychological wellbeing, quality of life and general health; noise sensitivity and personality traits; attitudes to noise sources; and demographic information. Questions were guided by pre-existing studies in the literature or by the use of pre-existing validated inventories, including:



WHO Quality of Life ScaleQ

Questions from Dr. Thorne on annoyance

Noise Sensitivity Questionnaire

SF-36v2 Health Survey

Sleep Disturbance from Epworth Sleepiness Scale, Pittsburgh Sleep Quality Index

Questions from Dr. Nissenbaum on Turbines and Health

The study sampled sound levels from wind farm locales and non-affected locales with full monitoring for low frequency sound and infrasound. The 23 residents sampled lived within 5 km of two wind farms while 2 were from locales without wind turbine activity.

In this comprehensive study, results of all the six categories were evaluated. As I have done in my research, the World Health Organization's Health and Noise criteria were central to the descriptions of harm. "Health" was defined as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Quality of life is a multifaceted concept: "An individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It is a broad ranging concept affected in a complex way by the person's physical health, psychological state, personal beliefs, social relationships and their relationship to salient features of their environment".

Further, the WHO Report of "burden of disease from environmental noise" - from 2011 and 2018 is a scientific evidence supported "exposure-response relationships" and case studies in calculating burden of disease. The report concludes "... environmental noise should be considered not only as a cause for nuisance but also a concern for public health and environmental health". In the 2018 WHO report on environmental noise, beside automobile traffic, railway noise and aircraft noise, evaluations were done on industrial wind turbines and leisure noise.

The WHO report considers sleep disturbance and its potential for adverse health effects. I would agree that sleep disturbance is the MOST significant concern and is the pathway to a full range of serious adverse health effects. Concordance that sleep disturbance produces major health endpoints accompanies most review of AHEs from IWTs. Most significant to myself, as a practicing Cardiologist for 30 years, is closed-linked data of sleep duration and serious cardiovascular outcomes (reviewed in Part - 2). Inherent with that association are important autonomically-mediated association with "chronic inflammation" that may trigger/promote the development of asymptomatic measurable (developing atherosclerotic obstructive vascular disease) and observable clinical cardiovascular endpoints such as hypertension and fatal and non-fatal heart attacks. ANYTHING a society can do to lessen cardiovascular disease development and its progression - including minimizing suffering annoyance from industrial wind turbines - should be considered paramount. This is particularly

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relevant when lease lengths of 58 years are being granted for projected continual operation of IWTs.

Comments on the Thorne's study results included:

- 1) The data suggests that the sample of individuals exposed to turbine noise, have, on average, substantially lower health-related quality of life compared to the community and clinical samples.
- 2) When exposed to wind farm noise and wind turbine generated air pressure variations, some will more likely than not be so affected that there is serious harm (also termed 'significant adverse effect') to health.
- 3) 91% of the respondents stated that turbines annoyed them inside the home while 9% said no. For turbine noise heard outside the home 95% of the respondents said yes and 5% said no. All report that wind turbines affect sleep and the ability to work is dramatically affected.
- 4) Families have moved away to sleep, (but) must still work the land and will not sell.
- 5) Headaches, although not serious adverse health effects, clearly effects quality of life. In response to the question: "What health effects such as headaches have you experienced since the turbines went online that did not exist previously", 24% responded with daily or constant headaches, 56 % experienced headaches 2-4 times a week, 64% experienced a tight scalp or band-effect around the head, 52% experienced blurred vision, 40% stated dizziness was experienced, 4% experienced chest pains, 52% experienced nausea, 76% state ear-ringing was experienced, 12 % experienced pressure in the ears and 60% experienced vertigo/balance problems. Of the persons who responded citing headaches as a problem, 80% observe that headaches only occur when the turbines are operating. Most of the respondents noted that these effects are not experienced all the time but often enough to be debilitating.
- 6) In response to the question: 'How long did it take after the turbines started before you felt unwell', 35% of the respondents said fairly quickly (a month or less) and 56% said 6-8 months. Of those who responded "fairly quickly", there were some who became unwell almost immediately. These respondents now find it very difficult to return to the locale to work when the turbines are operating as they suffer from headaches and/or nausea almost immediately. In 56% of the responses the symptoms improve/abate fairly quickly when the person leaves the locality.
- 7) Dr. Thorne provided some insights into experiencing IWT noise. "Wind turbine sound has a unique nature that is variable over time and highly dependent on wind speed and directions, as well as locale. Some standards refer to "audible characteristics" such as amplitude modulation, tonality, impulsiveness and so on. Observations at the different locations near the wind farms under different weather conditions and measurement distances indicate the sound of turbines are individually observable (swish, rumbles, clunks, whines) at distances of 200-500 meters. (500 meters is the setback distance proposed by Mr. Clifton in his Wind Ordinance draft). At around 900 meters only clearly distinctive turbines are identifiable (swish, rumbles) and by 2000 to 3000 meters, the sound of turbines is "cumulative" and is heard as a general source of noise. At each wind farm, turbines could be "clearly " heard at dwellings

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approximately 2000 meters from the nearest turbine. The sound of turbines can be heard 2000 meters both upwind and 2000 meters downwind as well at an angle to the turbines. The sound, with turbines operating, can be described as a steady rumble with a mixture of rumble-thumps. The general character over a long time period of an hour or so is of a steady rumble".

8) In this study, at 2000 meters, IWT sound is perceptible outside or inside a dwelling. The sound of turbines is often "clearer" inside as higher frequencies are reduced through the building fabric.

In his "Discussion Summary" section from his 2012 study he commented that:

- 1) By necessity, the investigation was applied to residents who claim they are adversely affected
- 2) All those studied WERE adversely affected by wind farm activity, ...and there was evidence of serious harm to health.
- 3) The subjective experience of annoyance is a common reaction to noise. Different individuals can exhibit different annoyance reactions to the same noise, and these individual differences can be ascribed partly to differences in noise sensitivity.
- 4) The finding suggested that the individuals living near the wind farms of this study have a degraded Health-Related Quality of Life through annoyance and sleep disruption and that their health is significantly and seriously adversely affected (harmed) by noise.
- 5) Serious harm means more than "mere" annoyance and that it can be quantified in terms of reported illness, sleep disturbance or other physical effects.
- 6) Definitions of 'serious harm' were postulated:
  - a) an exposed individual is adversely affected to the extent that he or she is obliged to remove himself or herself from the exposure in order to mitigate the harm; and/or
  - b) if three or more serious adverse health effects are recorded for an individual. Three serious adverse health effects are established from this study as being:
    - i) Sleep disturbance with a global PSQI >5 (validated sleep study)
    - ii) a state of constant anxiety, anger and helplessness
    - iii) an SF36v2 mental health value of <40 (validated health survey)

I have researched and asked experts in IWT-related matters, what Wind Energy thought of this study and the conclusions Dr. Thorne produced that show "conclusively" that IWTs can cause serious AHEs. Those experts reported: little, if any response was generated by Wind Energy. This appears to have become their "normal response" of Wind Energy, i.e. unless it can support their narrative, they don't talk about it.... hoping, like this study and the proceeding long list of studies and data and basic science supporting that IWTs do cause adverse health effects, will simply "go away".

Included in this manual is a fascinating sequence of verbatim comments made by residents who were severely harmed by IWT Noise and, as a result, felt to consider or proceed to achieve evacuation of their homes. We, as the public (unless we are close acquaintances with affected residents) do not directly hear these comments of distress. I am sure that participating resident granting easement have the same "scale of distressed comments, but are forbidden by contract to express those reactions. Please read the 6/28/2020 article included in this Part's Appendix, by Carmen Krough, et al, "Wind Turbines: Why Some Families Living in Proximity to Wind Energy Facilities Contemplate Vacating Their Homes: An Overview of Findings". The intensity and depth of their reactions is quite personal and revealing.

Later, Dr. Thorne in his 2014 textbook, reviewed "Wind Farms and Health Effects". In his chapter, he provided a very brief introduction to a small sample of experts who have published evidence of the topic of wind farm activity and its potential effect on human health. Up front, he highlighted **the ultimate connection: "If there were no ill effects before the wind farm started operating, and there are a lot of complaints about adverse health effects now that it is operating, what has changed"?**

- 1) Dr. Eja Pedersen in Human Response to Wind Turbine Noise: Perception, annoyance and moderating factors" present an understanding of how people who live in the vicinity of wind turbines are affected by wind turbine noise and how individual, situational and visual factors, as well as sound properties, moderate the response. She has written other works on IWT health effects.
- 2) Dr. Nina Pierpont, MD, PhD (Academic Pediatrician) presents work relating health effects of wind farm activity. Her work presents an important body of knowledge that has been extensively peer-reviewed. She states the following symptoms: "... sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory and panic attack episodes associated with sensations of internal pulsation or quivering when awake or asleep". Insight into the understanding and threshold of defining adverse health effects by Wind Energy were exemplified by their "acoustical science leader", Dr. G. H. Leventhall as he critiqued Dr. Pierpont's work. (As one reads the following quote in his review paper, keep in mind Dr. Leventhall's absolute rejection that wind turbine ILFN contributes to adverse health effects). "I am happy to accept these symptoms, as they have been known to me for many years **as symptoms of extreme psychological stress** from environmental noise, particular low frequency noise. The symptoms have been published before. The so called "**wind turbine syndrome**" **cannot be distinguished from the stress effects from a persistent and unwanted sound**. These are experienced by a small proportion of the population and have been well known for some time". In later correspondence, Dr. Leventhall confirms his belief that there is no such thing as wind turbine syndrome. This writer/reviewer believed Dr. Leventhall acknowledged (in his first comment) that the psychological and associated physical stress originated from industrial wind turbine noise. Symptoms reflect the underlying adverse health effects. Moreover, when IWTs are "forced onto an otherwise unaffected population" some of whom then develop these

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symptoms, it highlights the immoral and unethical behavior of the Wind Industry contractor who "causes" those adverse health effects. It is NOT the resident's fault that he and many of his neighbors develop "ill-health consequences" that can go on to precipitate other health effects.

- 3) This central concept of Wind Energy's actions to deprive a resident of his health also extends to his well-being, quality of life, and amenity. Dr. Daniel Shepherd specializes in public health and psychoacoustical studies. He sees "primary health" as embracing the concept of health in all policies (e.g. labor, environment, education) and so includes not only the treatment of disease but its prevention. At the community level, good health can be facilitated not only by the pursuit of healthy lifestyles but also with the provision of restful and restorative living environments. A prominent factor determining the restfulness of a living space is the level of privacy and intrusion by community pollutants, including smell, air quality and noise. He finds that "there exists compelling evidence attesting to the impact that community noise can have on health. A number of interacting factors combine to determine an individual's response to noise. As such, noise level should not be used as the sole metric with which to judge the potential health effects of noise. Annoyance can lead to degraded health, quality of life and impaired sleep, while disrupted sleep can lead directly to severe health deficits. Noise sensitive individuals are more susceptible to the negative effects of community noise. Turbine noise is a type of community noise and likewise has the potential to impact health and wellbeing. Evidence to this effect now exists in the peer-reviewed literature. Dr. Shepherd has proposed a simple model demonstrating (in the rural context) feasible mechanisms exist by which wind turbine exposure can degrade health and wellbeing: turbine noise can lead directly to annoyance and sleep disturbance (i.e. primary health effects) or can induce annoyance (suffering) by degrading amenity. Additionally, the trait of noise sensitivity constitutes a major risk factor, with annoyance and sleep disturbance the likely mediators between noise sensitivity and health. In relation to secondary health effects, it would be expected that quality of life will be affected immediately, while stress-related disease emerges from chronic annoyance and sleep disturbance over time.
- 4) Clarifying the central risk of sleep disturbance (which I too, have seen in patients presenting with heart arrhythmias and obstructive sleep apnea), Physician Dr. Hanning, reports that "inadequate sleep has been associated not just with fatigue, sleepiness and cognitive impairment but also with an increased risk of obesity, impaired glucose tolerance, high blood pressure, heart disease, cancer and depression". Sleepy people have a substantially increased risk of traffic accidents.
- 5) Michael Nissenbaum, M.D., has conducted a study of the health effects of persons living within the Mars Hill Wind Turbine Project in Maine. He declared a "high probability" of significant AHEs for residents living within 1100 meters and a significant risk of AHEs in a significant subset of people living out to 2000 meters from an IWT. He listed:

- 1) Sleep disturbances/sleep deprivation and the multiple illnesses that cascade from

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chronic sleep disturbance

2) Psychological stress which can result in additional effects including cardiovascular disease, chronic depression, anger and other psychiatric symptomatology.

3) Increased headaches

4) Unintended adverse changes in weight

5) Auditory and vestibular system disturbances

6) Increased requirements for and use of prescription medications.

- 5) Dr. C. V. Phillips reviewed some epidemiologic principles in his testimony before the Wisconsin Public Services Commission. Based on his knowledge of epidemiology and scientific methods and his readings of the available studies, he summarized that:

1) **There is ample scientific evidence to conclude that wind turbines cause serious health problems** for some people living nearby. In addition, he commented on the observation of people vacating their home being an exposure-disease combination.

2) **Reported health effects, including insomnia, loss of concentration, anxiety and general psychological distress are as real as physical ailments, and are part of accepted modern definitions of individual and public health. While more difficult to study (less objective, presenting in "gradation"), they probably account for more of the total burden of morbidity in Western countries than do strictly physical diseases.** It is relevant and important to take the less intense versions of the problems more seriously in making policy decisions, while not ignoring the serious diseases.

3) **The reports that claim that there is no evidence of health effects (Writer's comment: commonly seen on Wind Energy websites and their "peer-reviewed" papers) are based on a very simplistic understanding of epidemiology and self-serving definitions of what does not count as evidence. Though those reports probably seem convincing (on first appearances), they do not represent proper scientific reasoning, and in some cases the conclusions of those reports do not even match their own analysis.**

"Effects of Wind Farm Noise and Vibration on People" in the 39-page chapter of the "Wind Farm Noise" Textbook. They authors summarized: There are many well-documented cases of adverse health effects resulting from both short- and long-term exposure to wind turbine noise. These symptoms

include nausea, dizziness, pressure (or fullness) in the ears and recurring sleep disturbance; in most cases medical professionals are unable to otherwise explain them. There are also a significant number of people who are so badly affected that they have had to leave their homes or have had to undergo medical treatment to address their (unexplained) symptoms. Sleep disturbance experienced by people living in the vicinity of wind farms manifests as prevention of the onset of sleep (insomnia) or the prevention of a return to sleep after being awakened.

(Writer's comment: Sleep disturbance as either shortened time in sleep due to insomnia or recurrent awakening **or** normal-sleep stage progression disruption due to "brief, non-awakening" events that results in delay or prevention of reaching deep slow wave or REM sleep have also been shown in formal sleep study evaluation with EEG (brain wave) monitoring. This sleep architecture fragmentation has been known for more than 20 years and is recognized by the World Health Organization. The 1999 WHO statements list 32 dBA as the audible threshold for sleep disruption.)

Continuing from "Wind Farm Noise": Ten to twenty percent of the population are easily disturbed from their sleep and a higher percentage can be expected to be found in rural areas (Hanning and Nissenbaum, 2011). Of course, a smaller percentage of the population (generally 5-10%, according to Thorne, (2013)), report serious health effects, although a considerably greater percentage suffer from annoyance and recurring sleep disturbance. In some cases, some members of the same family suffer terrible effects while others suffer no ill effects at all. The actual percentages depend on how far the residents are from the nearest turbine. In cases where they are **within 500 meters of the nearest turbine** (MAE's request as pursued by Phil Clifton (Supervisor) for the Madison County Wind Ordinance), **up to 30% of people may be highly annoyed and suffer some form of adverse health effect in addition to sleep deprivation.** As distance from the nearest turbine increases, the percentages of affected people decrease. Thorne (2012, 2014 - from the literature mentioned at this part's beginning), found that adverse health effects occur in some people when wind farm noise levels exceed LAeq,10min levels of either:

32 dBA OUTSIDE the residence

22 dBA INDOORS, if wind farm noise is at a level that is perceptible inside the home.

Thorne also concluded that noise that exhibited excessive levels of "fluctuation" that could contribute to adverse effects. He defined fluctuation in terms of LAeq and LZeq levels in 1/3-octave bands averaged over 0.1-0.125 msec. The LZeq metric is used to determine if amplitude modulation (AM) exists for low-frequency noise or infrasound, where LAeq metric is more likely to identify AM in the mid-frequency range. A difference of 2 dB or less between the peak and trough of the 1/3-octave band sound level was considered to acceptable, 4 dB was considered to be unreasonable and 6 dB or more was considered to be excessive.

In a recent study, McBride et al. (2014) found that some people living near wind farms had a lower quality of life than others due to increased levels of stress and poorer sleep. It also became apparent

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that the 'objective manifestations of health effects associated with noise-related annoyance may emerge after some years of exposure'.

The Cape Bridgewater wind farm has been the subject of studies by Thorne (2012) and Cooper (2015), who both found poor sleep quality and adverse health effects in residents. Cooper surveyed six occupants of three houses located between 650 and 1600 m from the nearest turbine. He found that these residents suffered from sleep disturbance, headache, ear pressure, tinnitus and an elevated pulse rate (an indirect finding associated with autonomic shifting toward more dominant sympathetic tone). The onset of these later four 'sensations' was found to be well correlated with changes in the turbine output power, caused by the following operating scenarios:

turbines starting up

increase in power of 20% or more

decrease in power of 20% or more

turbines operating at maximum power and wind increased above 12 m/s

Cooper also found that the infrasound environment with the wind farm operation was characterized by a mix of tonal noise and random noise and was very different to the natural environments, which is characterized by random noise only. He found that the total sound pressure level (denoted WTS - 'wind turbine signature') of the first 11 harmonics of the blade-passing frequency of the wind turbines was correlated with **unacceptable sensation perceived within infrasound spectrum**, such as those listed above. With (specific measuring tools), he recorded the peak levels of the first 11 harmonics. He then added them logarithmically to obtain what he referred to as the WTS (dB). He found that if the WTS (dB) exceeded 51 dB, an unacceptable sensation level would exist. He pointed out that all of the residents involved in his study have been exposed to wind farm noise for at least six years and had a heightened sensitivity to it.

(Writer's comment: The WTS stands for "wind turbine signature" which is a characteristic "equally-separated" discrete spikes (from 5-20 dB in size) above the time-based infrasound sound pressure recording. These spikes, consistent with the associated transient "strained" blade acoustic response thought to be due to blade stalling/bending during rapid load fluctuations).

Leventhall, (the principal and historical "managing" Acoustician for Wind Energy), in his submission to the Australian Senate Inquiry, pointed out that the large changes in wind farm output power would produce a noticeable change in audible noise produced by the wind farm and this change would draw people's attention to it and attract the recorded responses. He also pointed out that people in the Cooper study recorded increases in audible noise at the same time as they recorded increases in sensations, leading Leventhall to conclude that the adverse health effects experienced by residences were a result of audible noise, not inaudible infrasound, and that 'residents are reacting in the typical manner of highly stressed persons who are affected by a noise which they do not wish to hear'.



(Writer's comment: To my knowledge, actual audible-zone sound recordings (actual A-weighted rises in mean sound levels) correspond with the subjects' recognition of the 'increase in audible noise'. Why is this phenomenon only recognized after a considerable period of 'conditioning time' (years?). Why does this infrasound perception occur at long distances from the IWT - much farther than audible sound would travel? Has wind industry done anything to actively prove or disprove that speculation made by Leventhall? How would he explain the extremely discrete infrasound-origin spikes that correlated with the subjects' recognition? Has Wind Energy, in an effort to bring data supporting Dr. Leventhall's hypothesis, reproduced these findings themselves, then taken the recording of an infrasound-only spectrum that contained those "inaudible spikes" without accompanying audible sound content (filtered out) and verified that they were not the source of the reported sensation. Other Acousticians, report sensitized subjects when "coming into the visualized OR NON-VISUALIZED proximity of the windfarm (miles away), but too far away to "hear" (audible) but close enough to perceive more distantly-projected infrasound) report perceiving the disagreeable/disrupting sensations, and that they can recognize those tones during "heavy" wind farm operation. Residents frequently lament that they, as the suffering residents, "don't know why THEY have to prove these noise perceptions. They ask why the makers of the wind farm or the turbines themselves are not required to show they are safe and "free from harm"? Separately, if wind turbine noise doesn't produce adverse health effects as Leventhall wishes people to accept as true, then why would wind turbine exposure cause high stress in individuals and why would they recognize the noise (coming from the turbine) as disagreeable? In my opinion, Levanthall needs to 1) take professional responsibility for that statement and 2) prove his statement and produce data that is accepted by an independent (not from Wind Energy chosen reviewers) medical and acoustical sciences peer review.)

Doolan (2013) reviewed literature concerning wind turbine noise perception, annoyance and low-frequency emission. He concluded the following:

- 1) There is a similarity between findings of studies on low-frequency noise annoyance and wind farm noise annoyance.
- 2) There may be a link between personal and social moderating factors and annoyance.
- 3) Noise levels that satisfy acceptable A-weighted criteria can still cause annoyance, suggesting that the A-weighted noise level is an inappropriate criterion for specifying allowable wind farm noise levels.  
(Writer comment: This is particularly a concern with IWTs > 2 MW which have the capability to radiate perceptible ILFN much farther than less powerful IWT models. A-weighting is mostly used to judge audible sound levels. This observation gives STRONG SUPPORT to require regulation of IWT ILFN emissions by an objective limit, e.g. "shall-not-exceed 55 or 60 dBC Lmax (fast)
- 4) Spectral balance and temporal qualities of the noise should be included in any criteria of acceptability.
- 5) It is possible that a person's susceptibility to wind farm noise may change as the length of exposure increases.
- 6) (Greater clarification of particular IWT noise features causing annoyance is needed).

There were many other studies listed and described to the extent reported above. Some were questionnaire driven, all reported symptoms in varying and usually distance-dependent fashion. Association with IWT noise exposure and disturbance of sleep, psychological effects and "distress" in humans were noted. Exact association of which type (frequency range) noise is responsible is not clear.

Of particular note was the comment semantics in the Schmidt (2014) study that summarized the findings: ...At present, it seems reasonable to conclude that noise from wind turbines increases the risk of annoyance and disturbed sleep in exposed subjects in a dose-response relationship. There seems to be a tolerable limit of around LAeq of 35 dB. This would equate up to 46 dBA Lmax.

(Writer comment: Why is the resident required to "tolerate" a detectable noise level? Toleration implies ongoing annoyance which, in itself, is an adverse health effect). Audible noise thresholds avoid sleep disturbance is 30 dBA; 32 dBA and above disturbs sleep which cause adverse health effects).

### **Annoyance:**

In 1999, the WHO defined annoyance as "a feeling of displeasure associated with any agent or condition known or believed by an individual or a group to be adversely affecting them". Later, the WHO in 2011 declared that "high levels of annoyance caused by environmental noise should be considered as one of the environmental health burdens". Annoyance is considered to be an adverse health effect (AHE) by the WHO's definition of health.

Noise sensitivity is considered to be a stable, partly heritable personality trait. Noise sensitive individuals are more likely to have stress related disorders, anxiety, HAs and poorer sleep than the average. Several studies have concluded that **individuals do not "get used" to annoyance over time... they may become indifferent but not unaffected.** There is no dispute that psychological factors play a part in any reaction to turbine noise, to suggest that they are the sole explanation is contrary to evidence.

Annoyance "burden" varies directly with the sound levels. The "extent" of annoyance varies from study to study and among differing standards and statements from health organizations.

The 2016 Health Canada Study found that 13.7% of residents reported a high (very or extreme) level of annoyance above 40dBA.

A noise criteria reference chart for rural areas compared EPA community reactions from 1974 case studies to normalize community reaction to intrusive noise in rural areas:

Sporadic resident complaints begin at 30 dBA (Ldn) (level combined with day-night differences)

Widespread complaints at 34 dBA

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Strong appeals to stop at 44 dBA

Vigorous community action at 50 dBA

(The latter two sound levels represented 10 and 13% of the population as being very annoyed)

Noise in rural areas above 35 dBA are considered as "incompatible" by the American National Standards Institute

Above 40 dBA, the WHO has issued statements of concern (based on scientific sleep data that noise will produce sleep impacts - motility, sleep architecture disruption, arousals, chronic sleep deprivation).

Dr. Malcolm Swinbanks had a few comments about "annoyance"

- 1) Residents should not be described as "annoyed" by IWTs but rather "suffer annoyance". It is important to distinguish between an effect that has been externally imposed, rather than self-induced.
- 2) It has been suggested that blame lies with specific types of personality, implying that people are at fault who have sought a rural lifestyle because they value quiet and tranquility in preference to an urban environment. It is unlikely that many of those living in rural areas will have preselected personalities enabling them to be tolerant of unwelcome, external adverse intrusion.
- 3) Recently the argument has been advanced (please see Vestas request to the government of New South Wales, Australia to eliminate ILFN as a relevant consideration in placing IWTs) that "problems are created by activists raising alarm in advance of windfarm consent and installation and that the subsequent number of complaints can be directly correlated with the prior presence of such activists". This argument is meaningless if it fails to take account of the actual sound levels, setbacks and geography of individual windfarms, or the fact that there are reportedly many more complaints in the USA than in Europe, given that the **permitted sound levels in the USA are clearly significantly higher than elsewhere.**

Landowners or neighbors may not respond with complaints as they have entered into agreements with Wind Energy to not complain in exchange for cash payments. Also, a very significant number of landowners who have signed the 58-year term property easement, no longer live (or ever lived) on the property. It is my opinion that it is unethical to prohibit, by contract and implied penalty, that residents relinquish their right to voice concerns about potential or real adverse health effects that they are experiencing or will experience as a result of accepting financial return in exchange for placement of an IWT on their property. Such "gag-rule" contracts have been described as to be severely deficient in informed consent (particularly since wind industry refuses to acknowledge the potential health impacts of infrasound). Resolution of such resident/patient health concerns (though requests for medical services are likely not prohibited) will occur but, in an era of exploding health costs, will lead to a "potentially preventable" economic burden to our strained healthcare system.

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Annoyance is a health issue for many people living near IWTs. It is considered to be an adverse health effect (AHE) by the WHO's definition of health.

There is no dispute that psychological factors play a part in any reaction to turbine noise, to suggest that they are the sole explanation is contrary to evidence. Those "psychological factors" are far more likely to produce immediate complaints that frequently dissipate within weeks to months. Complaints that develop early and persist or develop more slowly (usually within 6 months) are most likely unrelated to any "negative emotional" response.

### **Low Frequency Noise**

The WHO, in 1999 stated, "It should be noted that low frequency noise, for example from ventilation systems, can disturb rest and sleep even at low sound levels. In that same publication, the WHO identified the importance of measuring low-frequency components. "It should be noted that a large proportion of low-frequency components in a noise may increase considerably the adverse effects on health" and that "the evidence on low frequency noise is sufficiently strong to warrant immediate concern". This was stated over 2 decades ago without substantial recognition or response by protective governmental agencies. Apparently that information is not provided to County Supervisors.

Leventhall was one of the first Acousticians to describe how low-frequency noise is a special noise problem - particularly to sensitive people in their homes. He indicated that annoyance to low-frequency noise increases rapidly with noise levels often starting just above the threshold of audibility. He also noted that the WHO places a special emphasis on low-frequency noise as an environmental problem and source of sleep disturbance, even at low levels. (Leventhall, as noted elsewhere, since has become the principle "Acoustician mouthpiece" of Wind Energy mostly through his denial of IWT-produced infrasound). The WHO acknowledges that a noise consisting of a large proportion of low-frequency components may considerably increase AHEs and should be limited to <40 dBA. Cummings, another Acoustician, notes that sound levels of 40 dBA trigger high levels of community pushback.

Amplitude modulation (AM) of infrasound and low frequency noise has adverse effects on the body. It is a term often used to describe wind turbine noise - usually referring to low-frequency noise, it can include infrasound. It refers to a sound that varies in intensity over either a short or long time period - generally on the order of seconds or fractions of a second. Nearby residents to IWTs find measurable AM sounds as highly disturbing with symptoms varying person to person and in a significant portion of such residents. These symptoms include sleep disturbance, annoyance, headaches, ear pressure or pain, dizziness, nausea, anxiety and a general feeling of distress or discomfort. Some of the rarer symptoms are blurred vision and memory loss.

There is extraordinarily strong evidence that other forms of less "annoying" environmental noise can cause cardiovascular disease (hypertension, atherosclerotic vascular disease and fatal and non-fatal myocardial infarctions) as described elsewhere in this submission to the Madison County Board of Zoning. This is well documented in the 2018 WHO report on Environmental Noise. I have also made reference to two articles published in 2019 that appeared in world cardiovascular meetings and highly

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respected cardiovascular journals which link "impaired sleep (duration) to objective measures of vascular atherosclerosis and heightened rates of clinical events.

Nina Pierpont, M.D. (Pediatrician), PhD (Population biology) coined the term "Wind Turbine Syndrome" to describe a range of symptoms reported for 38 family members of 10 families who lived near IWTs. Her work has been very extensively peer-reviewed. More recent laboratory research, suggest that a variety of health symptoms may be due to ILFN stimulation of both vestibular and cochlear components of the inner ear.

### **Infrasound Recognition and AHEs.**

With most of the newer wind turbines (now 3 MW to 3.5 MW)- (as described in Australia)-increasing numbers of residents living within 10 km (6.2 miles) have suffered and are still suffering severe health impacts since the wind turbines started operating. Many have left their homes repeatedly and eventually permanently, to live in greatly diminished financial circumstances, as their homes are no longer habitable or saleable. Some resident become too "unwell" to work. Wind turbines are not the only source of impulsive infrasound and low frequency noise causing severe health damage. The same pattern of identical serious adverse health effects, sleep deprivation and home abandonments, sometimes out to similar distances are being report by neighbors to other known sources of infrasound and low frequency noise - at open cut coal mining, underground mines with large extractor fans, gas turbine power stations and other sites.

Berger (2015) noted three important aspects of wind turbine infrasound:

- 1) The sound is regular and pulsating in amplitude. The rhythmic thumping stimulates the inner ear sensory functions, causing a host of symptoms (nausea, chest pain, etc.)
- 2) Measurements of environmental infrasound are typically reported as average or RMS values. However, the peak values of the signal are what are likely to determine the detection threshold. The peak to RMS ratio for wind turbine infrasound is greater than the peak-to-RMS ratio for tonal sound used in infrasound thresholds testing, so the RMS amplitude of wind turbine sound underestimates its ability to be detected. (This is visually displayed on Fig. 7.7 from "Wind Farm Noise" which was placed in the appendix of Part 4),
- 3) Some people may be far more sensitive than others due to differences in physiology: some may not be bothered at all but some may suffer severe symptoms when exposed to the same infrasound levels.

**Inaudible** sound pulsations occurring at infrasonic frequencies emitted by wind turbines have been shown to cause perceptible sensations in a laboratory experiment by research Steve Cooper, an acoustician from Australia. The results were presented at the December 2017 Acoustical Society of America Conference in New Orleans. There he showed that:

- 1) He can reproduce in his laboratory the acoustic characteristics of IWT sound pressure pulsations occurring at infrasonic rates found in homes of people living near utility scale wind turbines who have

filed complaints of adverse sensation and health effects.

2) These inaudible acoustic conditions reliably trigger, in self-identified "sensitive people", sensations and adverse effects associated with the complaints by people who live in or near the footprint of utility scale wind turbines.

Conclusions included that:

1) Wind turbine sound emissions consisting of dynamically modulated pressure pulsations at infrasonic frequencies synchronized to the Blade Pass Frequency have been shown to cause sensations and other adverse effects under controlled laboratory conditions.

2) Alternative explanations, frequently offered by Wind Energy as the Nocebo Effect, are NO LONGER acceptable arguments, since direct cause and effect has been established.

### **Perception of Infrasound by a Deaf Woman**

Separately, another "experiment" was done by Dr. Steven Cooper involving a functionally deaf woman with auditory nerve damage. She claimed (and constantly suffered annoyance from) she could perceive (inaudible to her and to others) "when the IWTs were turned on or off or when they geared-up". During this witnessed demonstration (in the basement away from any visual clues of IWT operation, the utility operator agreed to (through phone interaction with Dr. Cooper) turn on/off and "gear-up" as Dr. Cooper requested. The deaf resident correctly (very shortly after initiation) recognized all the "test states" that were otherwise consider "inaudible" sound emissions. She explained the perceived signal as a sensation of pressure or movement in the air or structure of her home. She demonstrated this to Dr. Cooper by having him remove his shoes and socks and stand on a part of the floor of her home where the vibrations were most prominent for her. He was able to feel it. Dr. Cooper said that thresholds of sensation were experienced at narrow band sound pressure levels of 4-5 Hz at >50dB. Prior nominal (tonal) audible threshold for frequencies of 4-5 Hz is >100dB. He also did tests of ground vibration and structure response that showed the movement he felt was not from ground borne energy, but was from the home responding ("breathing") to the pulse pressure. When that pulse goes through a structure (home or one's body) small resonance are evoked that can be felt as pressure changes or if affecting the vestibular sensory organs, as motion.

Finally, in Appendix 3 of the July 25, 2011 "Noise-Con 2011" submission by Bray and James, they included comments from Alex Salt, PhD (14 December 2010) as below:

### **Infrasound Perception from Wind Turbines and the Inner Ear? Dr. Salt's view:**

There is controversy whether prolonged exposure to the sounds generated by wind turbines adversely affects human health. The unweighted spectrum of wind turbine noise slowly rises with decreasing frequency, with the greatest output in the 1-2 Hz range. As "conventionally understood" human hearing is insensitive to infrasound (needing over 120 dB SPL to detect 2 Hz), it is claimed that infrasound generated by wind turbines is below threshold and therefore cannot affect people. The

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inner hair cells (IHC) of the cochlea, through which hearing is mediated, are velocity-sensitive and insensitive to low frequency sounds. The outer hair cells (OHC), in contrast, are displacement sensitive and respond to infrasonic frequencies at levels up to **40 dB below those that are heard**. A review found the G-weighted (filter that will actually measure infrasound while A-weighting does not) noise levels generated by IWTs with upwind rotors to be approximately 70 dBG. This is substantially below the (tonal) threshold for hearing ultrasound which is 95 dBG but is above the calculated level for OHC stimulation of 60 dBG. This suggests that most wind turbines will be producing an unheard stimulation of the OHCs. Whether this is conveyed to the brain by type II (incoming, sensory) fibers or influences other aspects of sound perception is not known. Listeners find the so-called amplitude modulation of higher frequency sounds (described as "blade swish" or "thump") highly annoying. This could represent either a modulation of audible sounds (as detected by a sound level meter) or a biological modulation caused by variation of OHC gain as operating point is biased by the infrasound. Cochlear responses to infrasound also depend on audible input, with audible tones suppressing cochlear microphonic responses to infrasound in animals. These findings demonstrate that the response of the inner ear to infrasound is complex and needs to be understood in more detail **before** it can be concluded that the ear **cannot** be affected by wind turbine noise.

### **Measuring Infrasound**

To fully assess all potential annoying or health-damaging sound components being emitted from IWTs, methods of measuring sound must:

- 1) utilize instruments able to monitor the whole spectrum of sound
- 2) be conducted inside as well as outside homes or at property lines if sound is regulated there.
- 3) produce results in narrow bands **not** one-third octaves or dB(A) as is currently standard
- 4) must continue over sufficient periods of time, to cover most if not all environmental conditions (wind speed and direction, etc.)

### **The Concern that IWTs Can Facilitate Development of Cardiovascular Disease:**

The WHO data review boards (Principally Measuring **Environmental Noise Data**) measured 3 critical health outcomes: **(Taken directly from 2018 WHO statement)**

- 1) Cardiovascular Disease: ischemic heart disease (angina, myocardial infarction (heart attack), hypertension.

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**Noted that cardiovascular disease has important health consequences and can lead to more severe disease and/or mortality.**

2) Effects on sleep: Percentage who were highly sleep-disturbed (via data from):

- A) self-reported and assessed with standardized scale
- B) Formal sleep studies (PSGs) - probability of additional awakenings
- C) Cardiac and BP measures during sleep
- D) Motility measures of sleep outcomes in adults
- E) Sleep disturbance in children

Noted that effects on **sleep may be in the causal pathway to cardiovascular disease.**

3) Annoyance: reflected by the percentage of the population that is highly annoyed  
assess with standardized scale

Noted that large proportions of the population are affected by noise annoyance, even at relatively low exposure levels. **Annoyance may be in the causal pathway to cardiovascular disease.**

**\*\*\* Again, the three links (or causal pathways) to cardiovascular disease are from environmental noise (directly measured increased incidence, due to effects from sleep disruption and annoyance)**  
**\*\*\***

The data directly from available IWT exposure studies is considered "conditional" with available studies not being of sufficient "power" to currently be consider the evidence to be "strong enough" to include IWT noise. **NONE** of the available data suggested otherwise. Notable is that wind turbine noise has been described as having a character that makes it far more annoying and stressful than other sources of noise at the same A-weighted level, including traffic and industrial noise. Additionally, Thorne, has pointed out that human perception of noise is based primarily on sound character rather than sound level, and that wind turbines are unique sound sources that exhibit special audible and inaudible modulated and tonal characteristics.

(Writer's comment: Like many "triggers or responses" in biological systems, thresholds for presumed autonomic shifting to heightened reactionary sympathetic tone is likely NOT a single feature...such as a discrete noise level...but include other features such as quality of the annoying stimulus or unique factors present in "vulnerable populations").

Particularly noteworthy are the WHO recommendations to policy-makers to reduce exposure from wind turbines in the population exposed to levels of 45 db Lden. Other forms of environmental noise which also had recommended noise levels were:



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**Aircraft:** 45 dB Lden, 40 dB Lnight

**Railway:** 54 dB Lden, 44 dB Lnight

**Road Traffic:** 53 dB Lden, 45 dB Lnight

**Industrial Wind Turbines: 45 dB Lden** - nothing specified for night given inadequate data to allow a recommendation. The review data committee conditionally recommended that policy-makers implement suitable measure to reduce exposure from wind turbines in the population exposed to levels above the guideline values.

The reported guidelines were published **BY** the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience, as a large body of the evidence underpinning the recommendations was derived not only for European noise effect studies but also from research in other parts of the world - mainly America, Asia and Australia.

### **What is Going On: Deep Dive into a Much Deeper Pond**

The human organism is thought to have evolved in a "natural" environment where survival was dependent upon unique capabilities of hearing and vision among other senses that were selected and honed over millions of years. The brain became the "central processor" of information from all the traditional senses and also received and responded through the peripheral nervous system. Within the peripheral nervous system, there is the autonomic nervous system that influences the function of internal organs. Simplistically, it is a "control system" that acts largely unconsciously and regulates bodily functions such as heart rate, digestion, respiratory and many others. Within the autonomic nervous system, there are two major branches - the sympathetic and parasympathetic nervous systems. The sympathetic nervous system is often considered the "fight or flight" system using "activating" chemicals such as norepinephrine as a neurotransmitter with epinephrine (adrenaline) being produced by the adrenal glands. The parasympathetic system is often considered the "sleep and eat" system and chiefly uses acetylcholine to act on two different receptors. In many cases, both of these systems have "opposite" actions where one system activates a physiologic response and the other inhibits it. In practicality, there is an "undulating balance" - or responsive "rheostat" that can both momentarily change an ongoing balance or can more persistently change (slightly) toward one side or the other depending on environmental or individual "body-regulating needs."

As a heart rhythm specialist, I am referred patients having the consequences of heart attacks presenting as palpitations representing "PVCs" or "non-sustained lower heart chamber (ventricular) abnormal rhythms" or, more serious, aborted sudden cardiac death. Genetics combined with environmental/behavioral factors can produce atherosclerosis which is a complex disease process facilitated by high cholesterol, hypertension, smoking, glucose intolerance among others. The development of the atherosclerotic "plaque" has been worked out showing a very complex genesis. An over-riding factor in the disease background is our controlling nervous system. One system - the autonomic nervous system - plays a both protective and facilitative role for our body's survival and

functioning in responding to the "outside environment" or regulation of normal day/night activities. As just mentioned, this is achieved by both hormonal and neurotransmitter actions. It is truly remarkable how a perceived threat can almost instantly change the ease of individual atoms transferring through a single cell membrane on specific portions of our heart's "wiring system" or can subtly shift membrane thresholds that trigger contraction of individual heart cells. Long-term or "tonic" activation of the "fight-or-flight" limb of the autonomic system (sympathetic system) can have the effect of disrupting a "normal balance or "homeostasis" that has the potential consequence of causing "more rapid aging" - this being associated with body adaptation processes that turn out to be "destabilizing and disease producing".

Listed on a NIH (National Institutes of Health) web site (C Ayada, U Toru, Y Korkut: Hippokratia, 2015 Apr-June, 19(2):99-108 The Relationship of Stress and Blood pressure Effectors), the authors describe long-term stress physiological adaptation as different from acute stress and lay-out the chain of responses that are believed to occur. "Daily events cause chronic stress and have detrimental effects on the body (allostatic load) beyond the creation of "fight or flight" response to acute stress. In general, chronic stress has various effects, such as increased risk of cardiovascular disease, decreased baroreceptor reflex response, increased blood pressure and neuroendocrine response to new acute stress, decreased blood pressure and neuroendocrine response to repeated stress and increased basal blood pressure. These mechanisms work together harmoniously to help an organism survive under acute stress conditions and to prepare it for future threats. However, long-term activation of the stress circuit can cause many different health problems, including the increase of risk factors for cardiovascular disease. Although cardiovascular diseases progress in stress, especially in depression, the role of the RAAS (renin angiotensin aldosterone system) in the stress response is generally neglected. Indeed, the RAAS is one of the most important systems in the development of the pathogenesis of cardiovascular diseases." The authors describe the known effects of elevated norepinephrine from chronic stress that lead to increased hypoxia, cAMP levels, catecholamine metabolites and intracellular calcium. Through elevated renin from chronic stress, angiotensin II becomes elevated that leads to increased superoxide anions, ACTH levels, adrenal glucocorticoids, aldosterone and catecholamines. Together these two consequences may affect excitation-contraction matching, activated apoptotic ways, pathological hypertrophy, weakening of ventricular plasticity and left the ventricular ejection fraction, cardiovascular damage related to oxidative stress, increased ventricular hypertrophy, vasoconstriction, sodium retention, the development of myocardial fibrosis and facilitated cardiovascular remodeling. All these may promote the development of chronic heart failure.

They also describe the relationship of chronic stress and Endothelin-1. " ET-1 is found in most endothelial cells, and is the strongest vasoconstrictor agent (of ET-1,2 and 3). It is produced in the heart, kidneys, central nervous system and posterior lobe of the pituitary gland. ET-1 production is increased by many factors....and there is evidence that ET-1 production is increased in hypertension models". They continue with ET-1 effects on ET-A and ET-B receptors and resultant cardiovascular effects. Importantly, " in addition to its vasoactive characteristics, ET-1 stimulates smooth muscle cell proliferation through the same receptors. Thus, it contributes to vascular restructuring and leukocyte

adhesion. ET-1 generally tends to increase blood pressure and venous tone. Additionally, it is reported that the mitogenic effect of ET-1 contributes to the development of atherosclerosis... it is likely to be a component in the pathogenesis of cardiovascular diseases. ET-1 causes an increase in human vascular smooth cells which occur through platelet-derived growth factor, fibroblast growth factor and epidermal growth factor as a result of the response to ET-A receptor. That is why anti-endothelin treatment may not be only anti-hypertensive but also anti-atherosclerotic."

**This above excerpt is not meant to confuse or overwhelm** but to demonstrate that basic bench research and clinical trials leading to RAAS inhibitors and beta blockers have become quite sophisticated and that through this research, models of adverse health effects from chronic stress (producing sympathetic activation) are quite plausible and could be considered "causal".

### **Other Real-time Medical Examples of likely Autonomically-Mediated Cardiovascular Disease**

#### **Obstructive Sleep Apnea - A Disease Model to Consider for IWT Health Effects**

In my work I deal with arrhythmias - heart rates that are too fast, too slow or not "normal". Atrial fibrillation is fast becoming one of the abnormal rhythms that is consuming most of a "heart electrician's" time and an increasing amount of this country's medical resources. Atrial fibrillation likely has always been a part of the human condition but in the last 40 years - particularly after linking atrial fibrillation to embolic stroke - it has become a major health concern and threat. In this country, roughly half of the patients with atrial fibrillation have a disorder sleep - the majority of that labelled as obstructive sleep apnea (OSA). Briefly, it is the intermittent complete or partial interruption of airflow into or out of the lungs occurring as the patient transitions into deeper sleep with relaxing tonsillar soft tissue or the tongue creating obstruction to that airflow.

Patients with OSA are commonly overweight being frequently obese to morbidly obese. Their nights of sleep are characterized by multiple arousals triggered by intermittent surging adrenergic tone due to low oxygen in the blood caused by airway obstruction and resultant marked interruption of oxygen delivery to the lungs. They frequently snore loudly and characterize their nights of "sleep" as non-quenching and "never enough". They wake up tired and start the day exhausted and find themselves struggling at times with otherwise simple acts or mental calculations. They reluctantly admit and are told by others, that they "seem to be in a cloud". Treatment begins with confirming the diagnosis with a sleep study and usually the prescribing of a CPAP (continuous positive airway pressure) mask.

These same patients often also have type II diabetes, and hypertension (often quite labile (varying)), and hyperlipidemias. There is also evidence of endothelial (lining of blood vessels) dysfunction and hypercoagulability. As mentioned, they are frequently obese.

How did this all start? An unhealthy lifestyle is, of course, the superficial answer. More likely it started with our stressful lives (vaguely stated because it is) and living in the "passing lane" where sleep is considered a more optional need or where for some, obtaining quality, restorative sleep is compromised by where we live. Unfortunately, disordered sleep creates the metabolic condition where sympathetic tone and stress hormones are higher thus affecting glucose metabolism and the

triggers of hunger and satiety (1) which leads to obesity, insulin resistance, hypertension among many other things. Clearly, our genetics also have a role. Importantly, not everybody will react to "stress" the same, and, as a result, not everyone displays these later stages where discrete disease states are attained and then labeled.

From various cardiovascular studies some findings were presented: Patients suffering from OSA have >2.8 times increased likelihood of fatal cardiovascular (CV) events and nearly 3.2 times likelihood of non-fatal CV events. In a study of 182 men, ages 30-69 years followed for 7 years, 122 did not have OSA noting that their developed incidence of CVD as 6.6%. The remaining 60 with OSA had a CVD incidence of 36.7% - 5 times higher. Although long suspected, the incidence of heart failure (both with impaired and preserved systolic (contractile) function) has been correlated with sleep disturbance. In the Heart Health Study, mild-moderate OSA (AHI>10) was independently associated with a 2.38-times increased-odds of having heart failure. Hypertension - however defined - is quite common in our industrialized society. Extensive reviews by multiple investigators show that 50% of OSA patients have hypertension and 30% of hypertensive patient have OSA. Indeed, OSA - one form of a sleep disorder, is strongly associated with the development of hypertension which then can progress into a myriad of various end-organ diseases (strokes, heart disease, vascular disease, kidney disease, etc.).

**As seen with industrial wind turbines, suffering annoyance and tinnitus and sleep disturbance are adverse health effects that effect quality of life associated with dBAs of <40... but does not constitute the harder endpoints of cardiovascular disease which, when you look at the additional disease burden as a function of increasing sound levels, starts around 40 dBA. I would hypothesize that the transition from 30 to 40 dBA reflects autonomic shifting from likely intermittent to a more consistent "active/dominant" sympathetic tone that initiates the cascade of inflammatory response and adverse renin-angiotensin/aldosterone system (RAAS) activation that, over time, plays out the development of hypertension and atherosclerotic vascular disease leading to both subclinical and clinical ischemic (adverse organ blood flow) consequences.**

#### **WHO Comments about Environmental Noise Health Effects**

With the escalating threat over climate change triggering rapid industrialization of wind energy generation, both factions: pro- or anti- wind are now coming to grips with realities of what these massive machines and their visual impacts, sound emissions and effects on property values and wildlife, etc., **NOW** mean to their future energy security balanced against quality of life. The visual impacts are complex as individuals and communities try to adapt to its alien presence. The effects of wind turbines on man are relatively new with one of the earliest papers in 1987 (Kelley) surprisingly identified what is likely the most important consideration of chronic exposure to IWTs - infrasound and low frequent noise (16). It has only been in the last 15-20 years where we have seriously pursued defining IWT exposure and health impacts.

Intensive discussion and data collection leading to publishing that generate acknowledged "experts" that are pulled to friendly factions into unfriendly judicial interactions continues for one reason - the entirety of the health impact from IWTs - psychologic and physical - remains incompletely described.

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The "conflict" of the siting of these turbines is driven by financial rewards on one side and on the other side an imposition of enduring unnatural background noise and an honest concern for potential serious adverse health effects that most likely worsen through subliminally to significantly heightened stress.

Effects are hard to measure and they are seemingly wide-ranging in scope and variable among people. In the long-term manner in which residents are exposed living close to IWTs, to clarify and quantify "the full extent" of their long-term health effects will take a long time with carefully designed studies with enough people in both the exposed and "control" groups where confounding variables are recognized and accounted for that will quantifiable and statistically validated conclusions that then can best forge public policy. Such a complete and long-term study will likely NOT be done. Having said that, there currently is an enormous amount of information about AHEs from IWT exposure – enough to implement protective "siting regulations".

In the 2018 WHO report, under the area of "additional contextual factors", they again state that "very little evidence is available about the adverse health effects of continuous exposure to wind turbine noise". They did comment that proper public involvement, communication and consultation of affected citizens living in the vicinity of wind turbines during the PLANNING state of future installations is expected to be beneficial as part of health and environmental impact assessments. That said, it should be noted that MAE's first notification to residents living in the targeted turbine zone (except for those approached up to two years earlier to obtain easements) was not done until a few weeks before the first of three public hearings - essentially not allowing any education or research on the potential impact on targeted residents of a decision which did not request/involve their input. That report also states that residents living in the potential areas selected for IWTs may have greater expectations of the quietness of their surrounds and therefore be more aware of the noise disturbances. They also pointed out, unlike for traffic, railways or aircraft noise that with wind turbines, noise reduction interventions are more complicated than for other noise sources due to the height of the source and because outdoor disturbance is a particularly large factor.

Furthermore, they comment that noise "emitted from wind turbines has other characteristics, including the repetitive nature of the sound of the rotating blades and atmospheric influence leading to a variability of amplitude modulation, which can be a source of above average annoyance. This differentiates it from noise from other sources and has not always been properly characterized". They acknowledge (which pro-wind factions refuse) that "standard methods of measuring sound, most commonly including A-weighting, may not capture the low-frequency sound and amplitude modulation characteristic of wind turbine noise". These last three points are central considerations to the production of disordered sleep and subsequently in the production of pleomorphic (many faceted) adverse health effects.

In a 2019 German medical publications, Mathias Basner, Associate Professor of Sleep and Chronobiology at the University of Pennsylvania wrote an editorial entitled "Noise: What is to be done?" Dr. Basner also was a lead writer of the 2018 WHO publication on the "Burden of Disease from Environmental Noise". He pointed out that "health effects of noise go far beyond hearing". The so-called non-auditory effects of noise include annoyance reaction of the exposed population, sleep disturbance,

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school children's learning impairment and cardiovascular disease" (increased risk for hypertension and myocardial infarction). He continued by clarifying that "noise is defined as unwanted sound" and that the circumstances of the noise exposure play a crucial role for the non-auditory noise effects. Sound is often perceived as noise if one has little control over it and feels at somebody else's mercy. He stated that the "number of studies on the health effects of noise has increased considerably over the past few years. Even if high-quality studies are still missing for many noise sources and disease endpoints, there is little doubt among researchers that noise is an important risk factor for cardiovascular disease. He commented that we habituate (get used to) to many things - including noise. However, the habituation is rarely complete - **that is that the adverse health effects are still at work even if we no longer perceive noise as such.** Health impairments from noise exposure is the result of cumulative processes, i.e. health impairment is the result of relevant exposure over long periods of time.

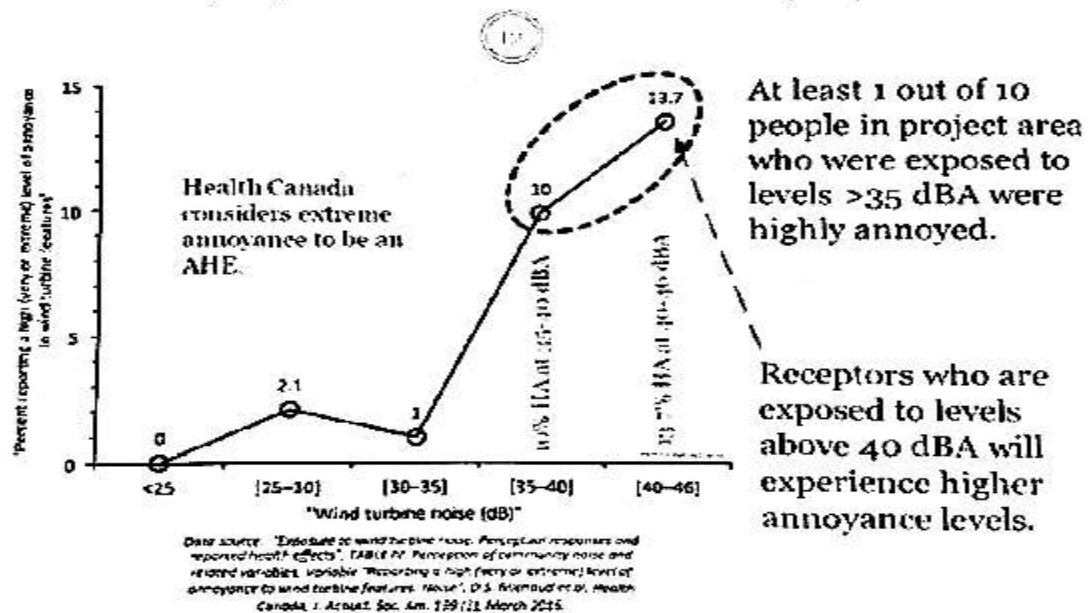
#### **Appendix:**

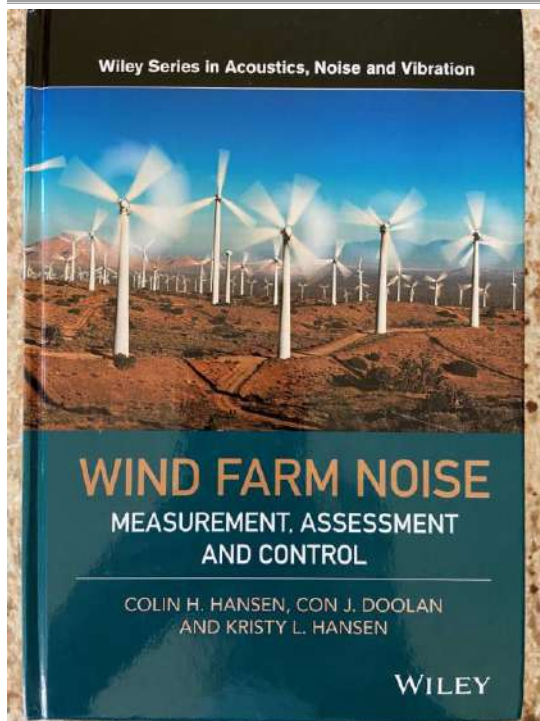
Beyond the physics and physical harm, there is an undercurrent of mental anguish and reaction that leads to AHEs. Open link below for 17-page June, 2020 article overviewing reasons why some residents are forced to vacate their homes.



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The Health Canada study found IWT noise highly annoying in a substantial number of people





**Wind Farm Noise:  
Measurement, Assessment and Control**

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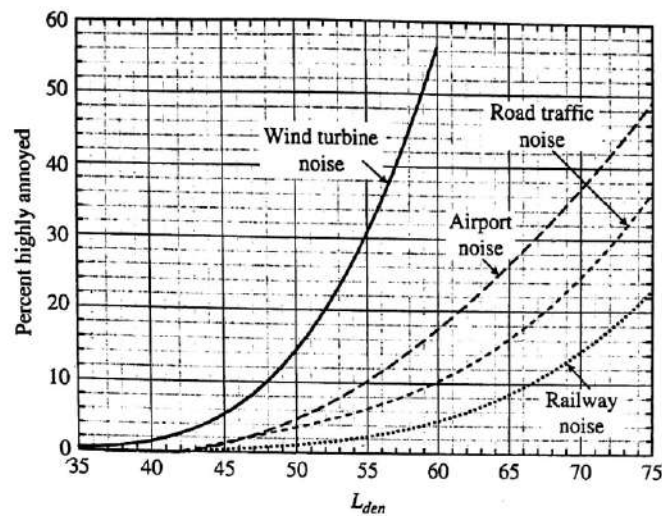


Figure 7.1 Dose-response functions for severe annoyance for wind turbine noise compared to transportation noise. Transportation noise curves from Miedema and Oudshoorn (2001) and wind farm curve from Janssen et al. (2008).

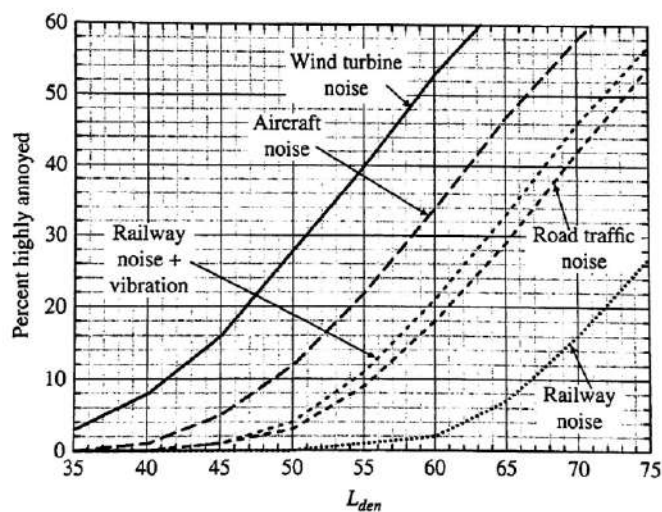


Figure 7.2 Dose response functions for high annoyance in communities found as part of the Health Canada study (Michaud et al., 2016)

to specify allowable wind farm noise levels, instead of a more appropriate measure that emphasises low-frequency noise and infrasound has arisen for two reasons.

1. Most current guidelines and regulations are based on ETSU-R-97 (see Section 1.4.1), which uses A-weighting criteria (see Section 2.2.11). Although this was in line with the current practice of environmental noise assessment, it did not take into account any annoying characteristics that made wind farm noise more annoying than indicated by its A-weighted level. Use of A-weighted criteria in isolation has resulted in

### 3.2 Walker

In addressing the impact of “wind turbine infrasound” Walker has utilised a low frequency speaker system with a D class amplifier to demonstrate wind turbine infrasound [13] instead of using actual wave files

Reference 13 includes the results of LAeq FFT analysis of turbines at Cape Bridgewater (Figure 55 in reference 4) to create a waveform computed as the sum of the sine waves at the six peak spectral amplitudes. Walker considered the wave as essentially a Ch-Wave truncated at the 6<sup>th</sup> harmonic.

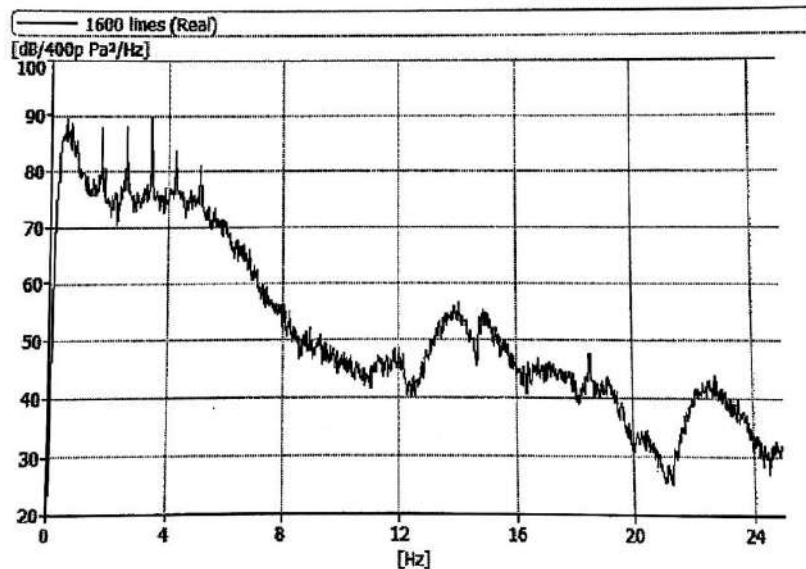


Figure 3: 1600 lines, 0 – 25 Hz FFT analysis – figure 55 from ref 4

**Figure 2: Wind Turbine infrasound Measurements**

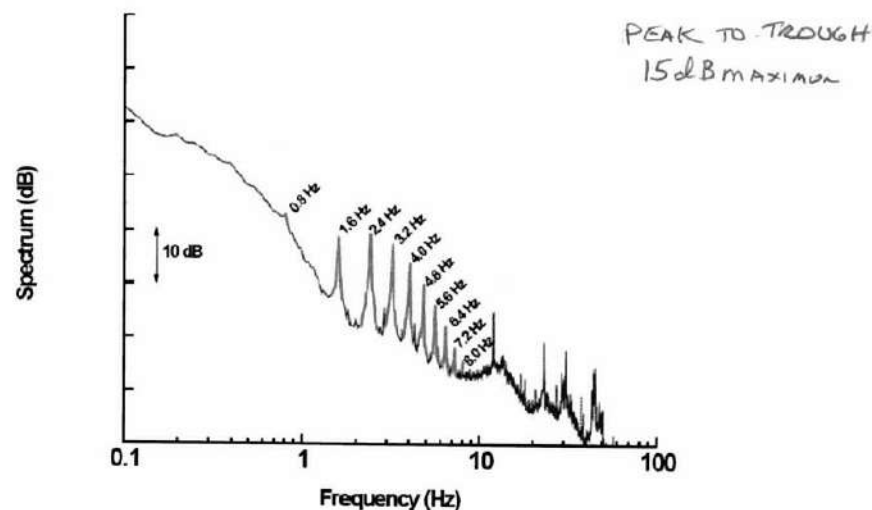


Figure 47 (from the Shirley Wind Farm report) provides a direct comparison of the WTS inside and outside a dwelling. In general the fundamental frequency (the blade pass frequency) is found to have a lower amplitude than the 2<sup>nd</sup> – 5<sup>th</sup> harmonics of that frequency).

In looking at the WTS it is necessary to have the appropriate instrumentation that can accurately record the WTS in that many microphones/sound level meters have dynamic and frequency limitations/roll offs below 10 Hz (or lower) that affect the accuracy of the reported results (see Section 10 on Measurement Uncertainty).

The presence of the WTS occurs when the wind farm is operating but not when the wind farm is shutdown, or alternatively in the "natural environment". As identified in the above extract from Health Canada the WTS has the ability to isolate the operation of a turbine/wind farm in an environment. The WTS has been recorded by the author and Hansen [31] out to 10 km from an operating wind farm and is readily apparent at the three houses used in the subject study



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Part 7: Selected Topics

Nocebo Effect

**This concept is a central piece of quoted evidence by Wind Energy to explain the origins of "annoyance" as being a psychological response, or an "attitudinal defect" of residents.** This was directly mentioned by a physician (neurologist/sleep specialist) who was a paid consultant for Mid-American Energy when he provided oral testimony at the original Madison County Board of Adjustments and by Peter S. Thorne, PhD - Toxicology, in his comments to the Madison County Board of Health.

The "Nocebo Effect" has been used to explain the development of "annoyance to IWTs" based on resident's generalized subjective impression of the turbine impact on their senses. This has been popularized (essentially only) by the Wind Energy faction. The WHO has completely rejected any relevance of the nocebo effect. Frankly, a person's reaction in having to acknowledge, accept and then daily endure an object constantly viewed as "negative" in the presence of their home environment - is "what it is". The first recorded "annoyance response" toward IWTs was observed during the first U.S. operation of a large wind turbine during initial prototype turbine operations (ND Kelley) in North Carolina in the 1980's. The usual symptoms of sleep disturbance, headache, tinnitus, irritability, problems with concentration and memory developed in a significant proportion of nearby residents - it is likely NONE of them had any pre-exposure negative opinions about the turbines.... it was after all, one of the very first times that an IWT had ever been operated.

In the textbook: Wind Farm Noise, the authors include this in their section on "The Nocebo Effect":

There are a few pro-wind-farm advocates who claim, via various web sites, that any adverse health effects due to wind farms are imagined, that wind farms do not make any audible noise and that complaints only began after anti-wind-farm activists began their campaigns to stop the construction of future wind farms. They attribute reported adverse health effects to mass hysteria and use pseudo-scientific terms such as 'mass psychogenic illness' or 'psychogenic nocebo phenomenon'. Others (for example, Knopper et al. (2013) agree that wind farms produce sufficient noise to annoy some people, but suggest that the only adverse effect of wind farm noise is annoyance, which can manifest as physical symptoms in some people. Whether this is the case or whether low-frequency noise and infrasound generated by wind farms have a direct adverse physiological effect, as suggested by Salt and Lichtenhan (2014) is still unproven. However, all of the literature claiming to prove that all adverse health effects are a result of a nocebo effect is based on suspect data, such as records of complaints produced by the wind farm industry, with no acknowledgement that over the past few years, wind turbines and the number of them in a wind farm have become much greater and that it takes time for people to realize what is causing their symptoms. Literature in favor of a nocebo-effect explanation universally fail to acknowledge work published by research in the U.S.A., New Zealand and Canada (Krogh, et al., 2011; Moller and Pedersen, 2011, Shepherd et al., 2011), who found that many wind farm neighbors who were in favor of wind farm operations prior to their construction, changed their view after the turbines began operating and adverse health effects became noticeable.

In support of the argument denying the nocebo effect, there are at least two instances of acoustic engineering professionals succumbing to illness during and soon after undertaking measurements in homes of people complaining of wind farm noise (Ambrose et al., 2012; Swinbanks, 2015). These symptoms came on entirely unexpectedly and the professionals involved did not have any prior expectations that they would suffer any effects. It is interesting to note that in the Swinbanks case, periodic infrasound was measured, with the highest peak level of 55 dB in the narrowband frequency spectrum and the cumulative effects of all the harmonics raising the peak level in the time domain to between 69 and 72 dB, indicating that spectral analysis can considerably underestimate the true peak of a noise. However, even this level is below what would normally be detected by a human subject, indicating that infrasound levels below the normal detection threshold may have ill effects on some people.

In the Punch and James article, the authors thoroughly review the reported "nocebo effect".

In the textbook "Wind Farm Noise" the authors wrote

"Much more extensive testing has to be done to determine a dose-response relationship that reflects real-world wind farm noise exposure and this will take a long time, even if funding becomes available to undertake the work. Before this work is completed, we must make do with case studies and self-reporting incidents. These latter have now become so numerous that the construction of future wind farms should only proceed with care, ensuring that resulting low-frequency noise levels and infrasound at residences is below the thresholds (discussed in section 1.6 in their textbook). There should also be a commitment by a wind farm developer to pay appropriate compensation to, or purchase residential property from, anyone suffering adverse effects within the first six months of turbines beginning to operate.

**A Need to Site IWT at Distances that Reasonably Achieve "Sound Safety" - Best Described as "Near" Background Levels; Is it 'fair' to Annoy /Harm a Sensitive Minority?**

The key to more healthy (mental and physical) coexistence is siting of IWTs far enough away from ordinary human interaction that annoyance is rare. How far away does it need to be - from not visible (to avoid any visible annoyance) to something closer which may always invoke some degree of annoyance in some people. People are "biologically designed" and thus generally behave in their responses in a "normally distributed fashion. There are some individuals will always recognize (and react "briskly") and some (at the other end of the curve) who will never respond. The majority in the middle will have "some recognition with an average response". At greater, and toward higher, physiologically-damaging levels of noise exposure, this normal distribution is no longer relevant with the "center" of the distribution shift rightward reflecting a high percentage of highly annoyed individuals.

Wind turbine sound is perceived to be more annoying than other equally loud sources (Pedersen, Bakker, Bourma & Van den Berg, 2009). Higher levels of annoyance may be partly explained by wind turbine noise amplitude modulation, lack of night-time abatement and visual impacts. Wind turbine tonal and audible low-frequency sound are also plausible causes of wind turbine noise annoyance

(Moller & Pedersen, 2011) and reported health effects (Minnesota Department of Health, 2009) and, may play an important part in the cause for adverse community reaction to large IWTs installed close to residences in quiet areas. Wind turbine low-frequency energy presents a recurring and/or unpredictable pressure signature, with audibility requiring forced judgement occurring over a much longer period of time than other environmental sources of low-frequency energy.

### **Sound Perception**

Harrison concluded that "IWTs caused annoyance in about 20% of residents living within a distance considered acceptable by most regulatory authorities and that for many of the 20%, the annoyance and sleep disturbance lead to adverse health effects (AHEs)". Thorne noted that human perception of noise is based primarily on sound character rather than sounds level, and that wind turbines are unique sound sources that exhibit special audible and inaudible modulated and tonal characteristics. He stated that sound levels of 32dB (A) Leq outside a residence and/or above an individual's threshold of hearing inside the home are markers for serious AHEs - especially among susceptible individuals.

In New Zealand (another country that has been seen as a huge proponent of alternative forms of energy), studies have concluded that people who live within 2 Km of IWTs have been found to have a lower quality of life, lower physical quality of life and lower environmental quality of life. Such victims also report experiencing a significant lower quality of sleep. There is a rapidly growing amount of literature by acousticians, academics and health professionals that focus on the adverse health effects of being in the vicinity of IWTs (Dr. Donald Deever, 6/13/2018 - Public Comment: Opposition to a Proposed Wind Turbine Project).

A 2011 Ontario Review Tribunal Decision found that wind turbines can cause harm if placed too close to residents stating: "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. (Erickson v. Director, 2011).

### **Human Rights and Social Justice**

What allows a Wind Energy company to decide they can study a wind map and begin planning a wind farm without the acceptance of all parties who might be involved? Was it the transition from small early farms turbines that were of essentially no consequence to health or scenery considerations to a slightly larger (but still not obtrusive and annoying) but more sophisticated models of the early 1970s that suddenly (because of a natural progression - "always bigger") produced the current, massive scale turbines that we see today? Have we lost sight of the consequences of that transition...in terms of annoyance, sound generation and being unconcerned about unknown biophysical ramifications? What was initially an image of closely-spaced turbines clustered along a remote canyon ridge in California became a sudden, uninvited, and "unstudied for safety ramifications" rush literally into our backyards. What may have been an easily accepted small structure a century ago became a forced placement of "dominating eyesore" with potentially seriously harmful health consequences and

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otherwise, completely unwanted. When did we stop considering the impact of these massive structures; when did we stop being considerate and respectful of our neighbors?

Canada has ratified an "international convention" which recognize the individual's right to the enjoyment of the highest attainable standard of health. The deployment of IWTs in Canada presents a contemporary example of the individual's right to health in conflict with competing interests as described in a May, 2017 article by Krogh and Horner. Through the review of government publications, documents and websites they confirmed the following health principles that have been adopted and supported by Canada. 1) Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. 2) Individuals have a fundamental human right to the highest attainable standard of health. 3) Governments have a shared-right responsibility to help Canadians maintain and improve their health, while respecting individual choices and circumstances. 4) A primary role and responsibility of government is to generate effective responses for the prevention and control of non-communicable diseases. 5) No one shall be subjected without their free consent to medical or scientific experimentation.

They quoted Health Canada's "broad mandate to protect and maintain the health of Canadians - including protecting people from risks in the environment where they work, live and play...." and the "...public expects government to mitigate those risks...." The main health risks of noise identified by the WHO were listed and exposure to IWTs were described as a plausible cause of reported health effects. Among many, the important ones identified were annoyance, sleep disturbances and all its consequences on a long and short- term basis, cardiovascular effects, hormonal responses and the possible consequences on human metabolism and the immune system. Despite these risks, the Canadian government has approved deployment of IWTs despite municipal governments having declared their jurisdictions to be unwilling hosts of wind energy projects.

The authors concluded, through review of government documents, peer reviewed literature and other references, "that Wind Energy deployment in Canada can be expected to result in harm to human health. The resulting harm is deemed avoidable and conflicts with the individual's fundamental human to the highest attainable standard of health". Furthermore, they stated that "governments have a responsibility to help Canadians maintain and improve their health by generating effective responses for the prevention of avoidable harm. Individuals have a right to make informed decisions about their health. IWT knowledge gaps and potential risks to health should be fully disclosed". Individuals should not be exposed to IWTs without their informed consent.

The same set of protections should apply to residents of this county. The owners of the wind turbine and/or local government do NOT fully know the full extent of adverse health consequences of chronic exposure to wind turbines. Industrial Wind Turbines have NOT been shown to free of adverse health consequences. If, upon completing informed consent of the unknown risks, the resident decides not to accept the risks, then it should not be permissible that wind turbines be placed within a distance where AHEs are potentially deemed possible given our current understanding (approximately 1.25 miles to avoid sleep disturbance due to ILFN - see below in Table where various investigators have submitted their recommendations).

The real question: Why is it the responsibility of the potential sufferer (some would say likely) to prove the proposed adverse health effects rather than the initiator (Wind Energy proponents) of the risk to adequately demonstrate the absence of health consequences prior to initiating the risk.

If IWTs are used, they should be sited such that their potential negative impacts are profoundly curtailed and that nearby resident's rights to live in a healthy environment are honored - especially their right to live and raise their children and grow old - both children and the elderly being considered more vulnerable to wind turbine noises.

Shain (2011) point out that wind farms represent a trade-off of adverse health effect of a few to beneficial health effects of many in the form of reduced carbon emissions. (That argument was voiced by a number of citizens at various County hearings). There is also an inherent argument that the government can interfere with the rights of a few for the benefit of many. However, in many other cases, the few disadvantaged people are usually fairly well compensated by the corporation causing the disadvantage. Unfortunately, the same is not true for people adversely affected by wind farms. **The rapid multiplication of wind farms in recent times seems to be in conflict with the precautionary principle, that would require that a particularly industrial activity not be undertaken unless there is no doubt that such an activity will not harm any people.** In many countries there is also a common law requirement that there is a duty to ensure that one does not cause predictable harm to their neighbor's interests.

### **Vulnerable Populations**

The United States accepted the WHO's constitution in 1948: Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

In 1989, the "Rights of the Child" was unanimously adopted by the UN General Assembly with 193 countries ratifying - the most widely ratified human rights treaty.

The proclamation state that "childhood is entitled to special care and assistance".

WHO - defines vulnerable groups of children as:

The fetus and babies

Preterm, low birth weight and small for gestational age babies

Children with dyslexia and hyperactivity

Children on "ototoxic medications"

Who is most affected?

Children require more sleep than adults

Sleep disturbance at night can lead to an increase in medical visits, spending on



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medications... affects families' budgets and countries' health expenditures

Autism: in a survey of 17,000 children with autism spectrum disorders, over 40% were hypersensitive to sounds.

Concern over shadow flicker - noting shadow-processing mechanism are abnormal in autism (cast shadows interfere rather than help object recognition)

Autistic children and adolescents suffer from sleep problems, particularly insomnia  
40-80% higher than normal developing children

Children's learning is affected by noise - both at home and at school

Pierpont: Case Study: 7 out of 10 school-age children and teens did worse in school during exposure to turbines, compared to before or after, including unexpected problems in reading, math, concentration and test performance - noted by both parent and teachers. Teachers sent notes home asking what was wrong with children.

Over 90% of Pierpont sample of affected people - both adults and children, "had cognitive difficulties during wind turbine exposure - problems that linger and resolve slowly after exposure ended. These included difficulties with reading, math, spelling, writing, multitasking in kitchen and home, remembering a series of errands, maintaining a train of thought in a telephone conversation, following the plot of a TV show, following recipes and following directions to put together furniture."

Impairment of early childhood development and education caused by noise may have lifelong effects on academic achievement and health. Noise is an underestimated threat that can cause a number of short- and long-term health problems, e.g. sleep disturbance, cardiovascular effects, poorer work and school performance, hearing impairment, etc.

It is likely that children represent a group which is particularly vulnerable to the non-auditory health effects of noise. They have less cognitive capacity to understand and anticipate stressors and lack well-developed coping strategies. Moreover, in view of the fact that children are still developing both physically and cognitively, there is a possible risk that exposure to an environmental stressor such as noise may have irreversible negative consequences for this group.

Bronzaft (2011) pointed out the adverse effects of train noise on students in a classroom and showed that high achievers more often came from families that respect quiet and provided quiet areas for their children to study and sleep. In addition, he asserted that if parents are stressed by wind farm noise to the extent that they are suffering sleep deprivation, then their children are likely to suffer from poorer parenting.

### **Potential Concerns of IWTs in Proximity to Schools**

Schools are places of learning where speaking and listening are the primary communications modes. It has only been in the last approximately 20 years, that school planners and the general public became

aware of the significant negative effect of noise and excessive reverberation in the learning process. Studies have shown that students learn faster, and comprehend and retain more in proper acoustic environments and this is even more critical for the youngest students who are still learning how to pronounce words. The hearing impaired also require good acoustics. Studies demonstrate that children need the following:

- 1) An acoustic signal (e.g. speaking teacher) that is at least 15 dBA more intense than the level of the background noise.
- 2) Overall sound levels (e.g. speaking voice plus noise) that are no greater than 70 dBA throughout the room.
- 3) Background noise that is less than 35 dBA throughout the unoccupied room.
- 4) Sound absorbing materials such as acoustic tiles that minimize reverberation, resulting in reverberation times of less than 0.6 seconds in unoccupied rooms.

Children need these conditions because:

- 1) Young children are ineffective listeners for speech in noise until they reach adolescence, when they achieve levels of speech understanding similar to those of adults.
- 2) Young children do not effectively listen and understand speech in reverberant conditions.
- 3) Children are especially susceptible to ear infections that can impair hearing for weeks to months.
- 4) Many children (up to 20%) have permanent hearing loss as a result of congenital, genetic and environmental causes. All people with hearing loss are adversely affected by both background noise and reverberation.
- 5) Significant numbers of children are learning in a language not spoken in their homes. All people listening in a non-native language are susceptible to interference from background noise.
- 6) Many children have difficulty focusing their attention on speech in background noise, even though they have normal hearing sensitivity and are learning in their native language. These students have auditory attention and learning problems and make up an estimated 10-15% of the student body.

Evidence also shows that noisy classrooms require teacher to speak at vocal levels that cause stress and fatigue to their voices. Many teachers complain of tired voices, vocal strain and health concerns because of their need to speak at such high vocal levels. In quieter classrooms, teachers can speak at more comfortable levels and their voices can still be heard throughout the room. When classrooms meet the ANSI S12.60 standard criteria, communication will occur at a clear signal-to-noise ratio of +15 dB (i.e. speech signal is 15 dB louder than the background noise).

**To restate: For full-sentence intelligibility in listeners with normal hearing, the signal-to-noise ratio (i.e. the difference between speech level and the sound level of the interfering noise) should be at**

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**least 15 dBA.** Since the sound pressure level of normal speech is about 50 dBA, noise with sound levels of 35 dBA or more interferes with the intelligibility of speech in smaller rooms (taken from "Guidelines for Community Noise" from the WHO expert task force held in London, 1999)

Low-frequency noise, and even at low levels has unusual annoyance properties related to other frequency content or its absence. Situations of isolated low-frequency noise without other noise or with other noise of very low level may be more annoying than when other noise is present with the same or louder noise level.

Consider that turbines near schools and residential neighborhoods will impact people - both inside and outside. Inside, the ILFN will be perceived as "rumble" outside. Outside, the turbine noise will increase the background sound levels thus reducing the listening radius. Listening radius is our auditory perception of how quiet a community is based on how far away we can hear distant sounds. In a quiet rural community with quiet nights (30dBA or less at night), this distance can be a mile or more. With wind turbines, even those designed for 40 dBA at the homes, the listening radius will be a few hundred feet.

It should be clearly recognized that "learning" goes on at home as well as in schools. In addition, high quality, restorative sleep - a critical part of healthy brain development - is needed when children return home. Both audible (at sound levels of >30dBA) as well as perceived (not necessarily "heard") infrasound, low-frequency noise emitted from nearby wind turbines has been shown to disrupt normal sleep processes. Those disruptions have been described as producing "neuro-cognitive" developmental deficits. Several sound experts, particularly concerned about ILFN, suggest separations of >1-2 miles from IWT to home **to minimize but not eliminate the health risks.** This is particularly relevant for the community of Earlham, which, if the Arbor Hills windfarm extension into Madison County occurs, will bring a very large contiguous collection of large-scale IWTs located to the south and west of the town's perimeter. Minimal setbacks of only two miles may affect the learning environment of its schools, but also its citizen's health and dramatically discourage town growth. It is a completely avoidable likely problem. Placing IWTs as proposed in close proximity of the outskirts of any town is a virtual "death knell" for a small town's future - principally through the addition of a closely-created harmful environment and a lack of potential growth at the edge of town. I would suggest at least a 5-mile setback from current housing on the edge of town to the closest placed IWT.

### **Increased Cardiovascular Disease associated with Life in Rural Areas**

Although advances in health care have brought improvements in cardiovascular outcomes, cardiovascular disease remains the leading cause of death in the United States. Unfortunately, in recent years, declines in cardiovascular mortality have stalled with some conditions such as stroke and heart failure are showing increasing death rates - these trends have been worse for people living in rural counties in the United States. Madison County, Iowa is considered a rural county without an urban core. In the U.S., health outcomes have widened markedly between rural and urban areas over the past 3 decades and health outcomes are now significantly worse in rural than in urban areas. There is now at least a 20% disparity with rural counties having worse death rate as measured by "excess death

rate" per 100,000. Life expectancy gaps continue to separate over time - being >3 years shorter in rural counties as measured in 2014. Similar patterns have been seen for cardiovascular disease. Data from the 2017 Center for Disease Control and Prevention showed a 40% higher prevalence of heart disease among rural residents - a gap that has grown over the past decade. Rural areas have higher death rates for cardiovascular disease and stroke than urban areas and gaps are widening. Coronary heart disease death rates were significantly higher as compared with urban areas with rural residents having a 30% increased risk for stroke mortality. Rural women face higher maternal mortality rates with that mortality growth being driven largely by an increase in cardiovascular deaths.

Rural areas have significantly higher rates of uncontrolled traditional cardiovascular risk factors compared with urban areas. Rural populations are significantly older and have higher rates of diabetes mellitus, obesity and hypertension. Tobacco use is higher in rural areas than urban areas. Data from the Behavioral Risk Factor Surveillance System suggest that roughly 25% of adults in rural counties report active tobacco abuse compared with 16% in metropolitan centers. Rural smokeless tobacco use was 8.5% versus 3% in metropolitan areas.

Rural areas have a higher prevalence of obesity, diabetes, elevated lipid levels and hypertension. In addition to less favorable physical health, rural areas experience less favorable mental and behavioral health, which has been tied to cardiovascular disease incidence, prevalence and mortality in both adults and children. Rates of depression and suicide are higher in rural areas. Among children, suicide rates are nearly twice as high in rural as in urban locations and these differences are increasing over time. This does not appear to be related to social isolation and loneliness.

#### **Recent U.S. Upward Trending Death Rates from Hypertension - Over 3 X Higher in Rural Areas**

In data just presented in the last 6 weeks, the U.S. death rates from hypertension related cardiovascular disease rose from 2007 to 2017. This trend was noted to accelerate starting in 2012 while the rate of decline from cardiovascular deaths started to slow down since 2011; the two endpoints are felt related. Age-adjusted death rates rose from 18.3 per 100,000 to 23 per 100,000 people (probability for trend was <.001). The age-adjusted death rates rose 72% in rural areas and was 20% in urban areas ( $p < .001$  for both trends). Rates rose about the same for men and women. The authors of the report felt the rise to be due to many factors - including the rise in obesity and diabetes as well as disparities in the social determinants of health as well as disparities in health care access and delivery to these areas.

#### **Electricity Costs:**

MidAmerican Energy keeps emphasizing how Wind Energy will keep power costs low. My MidAmerican electric energy costs went up 20% last year. Having said that, the price of residential electricity has risen lockstep with growth in renewable capacity in Europe but not in the U.S., and because of these European residential rates are now roughly twice U.S. rates. (Energy, Environment and Policy - posted April 31, 2018 by Roger Andrews). The reasons for the difference are a) that renewables surcharges are added to residential electricity bills in Europe but not in the U.S. and b) that residential electricity bills in Europe have increased roughly in proportion to the amount of money spent

on renewable growth. Residential rates in U.S. states are set by state Public Utility Commissions that are legally obligated to set prices at levels that are fair to both consumer and providers. As a result, the European bill payer pays for new wind, solar, etc. while U.S. renewables expenditures are offset by adjustments to the federal budget that are not itemized but which ultimately get paid by the U.S. taxpayer. I have included a graph (2014 data) that correlates residential electricity prices in various European countries as a function of installed wind + solar capacity (Watts) per capita. (See graphs at end of this Part) The more installed renewables, the higher the residential electricity price. Denmark, the home of the IWT-manufacturing company that sells their turbines to MAE, has the greatest percentage of their power production from wind energy and also the highest cost per energy unit. In the U.S., a lot of the increased cost is absorbed by into the federal budget destined to be eventually paid by the taxpayer. Make no mistake, renewables are more expensive than existing methods of energy production.

But even more important, it is about the goal of less carbon production to achieve electricity. The total CO<sub>2</sub> production ("cost consequence") of IWTs facility manufacturing, erection, raw materials extraction/refining/transport and ongoing maintenance costs are all considerable. Every turbine has a magnet made of neodymium that comes almost exclusively from China that requires an extremely toxic mining and refining process that involves repeated boiling in acid with radioactive thorium as a waste product that has leached into the soil and is threatening ground water supplies in Inner Mongolia.

One must include the accompanying expenses of fossil fuel fired co-generation capabilities into the final comparison equation - that data is extremely hard to clarify. I also found another set of graphs that describe the obligate need of a co-generation plant working "with renewables" in order to provide continuous power 24/7 that can adapt to momentary changing of wind and solar energy resources. This was shown in the April, 2020 National Geographic Magazine in an Earth Day, 50th Anniversary Special Issue. It appears that by 2045, the total generation of renewable power in the U.S with be nearly equal to the power generation produced through natural gas - and that at a level equal to "peak coal" in 2007. Currently, wind energy makes up a larger part of renewable than solar but "not for long". Solar is projected to triple its share by 2050 to become the leading renewable. This is in large part due to the herein-evidenced rejection by landowners of having IWTs "placed harmfully close" to their residences. Add the energy for constructing power lines and major transformer stations, erection costs and dirt moving among others. In that same issue was the picture of steel rebar - soon to be encased in CO<sub>2</sub>-producing concrete for one of the bases of 120 future IWTs in Texas to produce 338 MW of electricity to power more fracking for oil and gas. The magazine briefly touched the issue of nuclear power in the U.S. commenting about the closure of several nuclear reactors, ... finishing their comments with "much of their carbon-free electricity will be replaced by emissions-rich natural gas". The debate about the future of nuclear is complex and increasingly ideological". Nowhere is there a complete discussion in this article about regenerative agriculture but instead unsubstantiated dreams of greater yields (with more chemicals, more genetics and the attendant need for energy to produce these "additives") on soils driven to "extinction".

Also, as equally concerning is the evolving reality of the under-realized functional lifespan of IWTs in

comparison to conventional energy production modes and the costs of decommissioning turbines faced with shorter functional service lifespans. When you see where a lot of the energy produced by Wind Energy is being used, it appears to be heading out of state. The calls by Wind Energy to achieve 100% of our energy sources will never be possible. Such "rally-cries" are delusional and serve as grossly inaccurate promotional misinformation for a failed concept to "save the planet". Robert Bryce's recent investigative journalism book "A Question of Power" clearly reviewed the financial and logistical impossibility of achieving 80% (let alone 100%) "renewable" electrical energy production in this country (mostly through analysis of the California effort, lithium-based battery technology, land-availability limitations and extraordinary costs. He also reviewed the merits of nuclear power as a much more viable source of "clean energy". One really needs to think about the misleading statements being made about the value of renewables. Instead, we need to focus on the real needs to change current patterns of energy consumption and dramatically increase carbon sequestration and perhaps re-consider looking in nuclear energy production options. In the final analysis, "it" will have to come to embracing future commerce with carbon credits. We need clear-thinking, realistic leadership with responsible allocation of our country's increasingly limited financial resources.

#### **Decommissioning Implications - Costs: Unknown and Skyrocketing?**

Comments from Isaac Orr - in Energy, Environment Sept 9, 2019 - while interviewing various wind energy experts....

Concerns for implications of relatively short useable lifetime of IWTs: Past turbines with 12-20-year lifespan based on experiences from Europe. Current U.S. experience with >10-year-old IWTs show significant needs to replace "blades and cells" despite the current IWT generation with reported 20-25 year expected lifespan. In comparison, coal-fired plants have 50-60-year functional life. Stated estimated total cost to taxpayers of the wind production tax credit between 2016-2020 will be \$23.7 billion.

Estimates for "tear-down" cost for a single IWT is \$200,000. Given roughly 50,000 wind turbines spinning in the U.S., decommissioning costs are estimated at \$10 billion. In Texas, this could mean a potential current expense of \$2.3 billion. This potentially would have to borne by landowners and counties pending financial viability and guaranteed protected funds for such actions. Options for upgrading with new models pending continuation of federal wind subsidies could be pursued but is not assured. There is significant disagreement about "set aside decommissioning funds."

Concerns: 1) extracting valuable materials from the turbines is not easy. Removal of copper from insulation would likely require significant labor costs, 2) Reducing the steel casings enormous sizes would require specialized cutting tools, 3) blades are high-tech wonders of composite materials which experts agree cannot be separated into its component materials and is thus worthless for recycling, 4) with turbine removal, the company is committed to restoring the site to its previous state.

In another story relating costs of decommissioning, it was reported that Germany is finding that disposing of their aging wind turbines could cost hundreds of millions of Euros **more** than previously

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planned and overwhelm Germany's capacity to dispose of non-recyclable wind turbine blades. Locally, the removal of 18 wind turbines in Chippewa County, Minnesota would cost, in 2019 dollars an estimated \$632,000 each. It would make sense to ensure that decommissioning costs are completely covered **at whatever time** (likely requiring periodic reassessment of cost with contractual obligations to increase "bond coverage") in their life cycle as clearly stated in permitting requirements. If they refuse to cover that anticipated decommissioning cost with "irrevocable" availability of funds for some future need, that should be seen as their "commitment" to civic responsibility and "partnering" with the county and its residents. Things, people and times change; get all the decommissioning cost coverage confirmed in writing and keep that amount current with real-time costs. I would also suggest that all litigation costs regarding this specific item (in the event of MAE/current owner's unwillingness/inability to perform) "shall be borne" by MAE. MAE should not be allowed to "off-load" this responsibility to an insolvent "shell" corporation. **IMPORTANTLY**, MAE/current easement owner should not be able to assume/acquire ownership of the entire easement property to produce equity for decommissioning costs.

Smaller wind farm companies, with fewer financial resources may be tempted to just "walk away" when aging turbines no longer spin a profit. Some experts suggest that this may occur even before wind turbines outlive their useful life as manufacturing warranties on the big turbines expire. What is unknown is "at what point does the cost of maintenance tip over to the point it's not worth maintaining a turbine?"

They note that as wind turbine manufacturing has improved, the length of warranties on these products has decreased dramatically and today the terms cover between 5 and 10 years. Despite the obvious paradox of improved manufacturing with advertised longer functional service periods **and** shorter warranties, many turbine manufacturers have found a valuable revenue stream in selling extended warranties. It "could get ugly" when we see turbines needing work, and are no longer under warranty and not generating enough electricity to keep running them". Such scenarios should be specifically addressed in Wind Ordinance language. (This will be another cost eventually passed down to the consumer).

### **Litigation: A Replacement of Science and Failure of Leadership**

Australian Senate Select committee on Wind Turbines held June 29, 2015 established that there is a **direct** pathway to disease resulting from wind turbine noise.

Since 2015, 248 government entities from Maine to California have restricted or rejected wind projects.

The following educational links were provided on a "gofundme" site to assist with grass-roots efforts by citizens affect by IWT threats to their health and way of life. The individual, Hamish Cummings has been working hard for years trying to expose the truth about wind farms, the approval process and ramifications of ill-sited wind turbines.

This is an example of what has been happening across the entire planet in response to "IWT forced community intrusions". It's NOT "NIMBY - (not in my backyard), it is NOT in anybody's backyard!

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Wind Energy works from the same "playbook".

## LINKS

Human Impacts: <http://windvictimsontario.com/>; <http://globalwindenergyimpact.com/>;  
<http://mothersagainstwindturbines.com/>; <http://waubrafoundation.org.au/>;  
<http://www.windturbinesyndrome.com/>; Recording Impacts: <http://www.illwind.org/> Property Loss:  
<http://windturbinepropertyloss.org/site/>; Fire: <http://turbinesonfire.org/>; Informative sites:  
<http://www.wind-watch.org/>; <http://stopthesethings.com/>; <http://quixoteslaststand.com/>;  
<http://www.windwiseradio.org/>; <http://www.friends-against-wind.org/>; Wind Energy Performance:  
<http://energy.anero.id.au/wind-energy> Links to over 2000 international anti-wind groups:  
<http://quixoteslaststand.com/worldwide-anti-wind-groups/>; <http://ontario-wind-resistance.org/>;  
<http://epaw.org/>; <http://na-paw.org/>; <http://www.windaction.org/>;

In another, more local case in Wisconsin that has been contested for over a decade in a state where turbine regulations exist at the state level:

The Brown County Town Health Board in Wisconsin recently declared Duke Energy's Shirley Industrial Wind Turbine Development to be a Human Health Hazard. The precise wording of the declaration follows: "To declare the Industrial Wind Turbines in the Town of Glenmore, Brown county, Wisconsin, a Human Health Hazard for all people (residents, workers, visitors, and sensitive passerby) who are exposed to Infrasound/Low Frequency Noise and other emissions potentially harmful to human health"

Human Health Hazard has been defined as a "substance, activity or condition that is known to have the potential to cause acute or chronic illness or death if exposure to the substance, activity or condition is not abated" (definition used in Brown County, Wisconsin Ordinance).

In the last 20 years, it has been estimated that over 5000 separate "anti-wind" coalition groups have formed in their desperate attempt to protect **their** life's work in their created homes, **their** view of land aesthetics and the importance of safe natural environments, **their** health - individual, family, community because **we** (wind energy victims and their representative leaders) don't listen and seek out safe compromise for **our** world. Again, lofty ideals.... but unique to this issue of "forced, unproven in safety, non-integrated to community wholeness" essentially unregulated and unsupervised placement of IWTs by Wind Energy industry primarily motivated by profits assured by non-consenting taxpayers. I recognize that industry incentives were approved by Congress, but **I would bet that Congress was never told the full story about potential health effects involving IWTs. If they had, they would've requested oversight and safe health standards.**



It is not clear whether affirming votes made by County Board of Adjustment or Supervisors to permit IWTs could create individual Supervisor or Madison County liability - having had specifically been presented with compelling data about IWT's inherent health risks and collateral negative impacts as projected with MAE's proposed plan. MAE has provided no facts nor supportive data to eliminate those potential "loss of quality of life or health" let alone "life and death" concerns. Again, Wind Energy has never been proven to be safe. This is even more concerning in that a supermajority of citizens polled within the footprint of the proposed Arbor Hills project have specifically stated that they did NOT want the turbines because of their concerns over health risks and violation of property rights. Indeed, MAE (through the comments made by their industry-supported speakers at the Board of Health hearings) has acknowledged that "annoyance" is a health risk **and** that it is possible/feasible/plausible that IWTs could cause sleep disturbance that has been associated with cardiovascular disease as seen with other environmental noise sources. Finally, Dr. Thorne, a spokesman for MidAmerican Energy who spoke at that hearing agreed with me (personally, in a private conversation) that Wind Energy has never proven their turbines to be safe (in terms of health).

### **SCADA and NRO**

Supervisory control and data acquisition are a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level process supervisory management, while also comprising other peripheral device like programmable logic controllers and discrete proportional-integral-derivative controllers to interface with process plant or machinery. The SCADA concept was developed to be a universal means of remote-access to a variety of local control modules, which could be from different manufacturers and allowing access through standard automation protocols. It is one of the most commonly-used types of industrial control systems, in spite of concerns about SCADA systems being vulnerable to cyberwarfare attacks.

The Human-Machine Interface (HMI) is the operator window of the supervisory system. It presents plant information to the operating personnel graphically in the form of mimic diagrams, which are a schematic representation of the plant being controlled, and alarm and event logging pages. The HMI is linked to the SCADA supervisory computer to provide live data to drive the mimic diagrams, alarm displays and trending graphs. In many installations the HMI is the graphical user interface for the operator, collects all data from external devices, creates reports, performs alarming, send notifications, etc. (Wikipedia)

Noise Reduction Operating Modes (NRO modes) are roughly considered to be a "throttle" option (as directed through SCADA) to control noise production and maximally achieve power production within the regulatory parameters. There is Mode 0 which is "pedal to the metal; noise be damned". Then there is NRO mode 1 which drops the energy output by 10% for a 1 dBA noise reduction. Each successive NRO mode, 2, 3, 4 and 5 each reduce the noise another 10% and in NRO mode 5 the noise reduced about 5 dBA. This is not economical for the operator, which is why they are better off selecting one of the new quiet blade design options which can reduce the noise about 5 dBA from the older style and less expensive blades rather than buying "cheap" and then being forced by complaints to run their equipment at 50% energy output at night in NRO Mode 5 to meet a penalty for violating the regulatory limits.

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### Blade Throw

During the Joint Supervisor/Public Wind Ordinance Writing Workshop, there was some discussion about the setback distance between the IWT and the residence. Mr. Clifton decided that 1500 feet was the distance he wanted. Concern over the distance from the tower to the property line was discussed with again, preference for MAE standard language usage of 1.1 times the total tower (including to the top of blade) height. There continues to be no guidance from the manufacturer about a safety zone **specific to the physical size of a given model**. As happened many times as the public tries to secure the physical safety of its property, again, the public was told that the same safety zone was recommended for the V-110 2MW IWT as was recommended for the less powerful and shorter V-90. Concern from the public (attending) of potential tower toppling/blade throwing/nacelle fire with ember showering were again mentioned and completely ignored by Mr. Clifton. One would think that a given product (in this case a turbine model, e.g. Vestas Model 110, 2 MW) - is perhaps slightly different than a previous generation product (e.g. Vestas Model V-90, 1.8 MW) and that new written, model-specific recommendations should be mandated. Perhaps the materials and their sourcing/purity/manufacturing/testing of raw materials and finished products would need to be done to assure maximal safety. As such, specific safety specifications need to be stated on product documentation that is made available to the consumer (MAE) but also should be made available to the county where the product is installed. Such important information would be a record of the testing specific to assessing component failures should be made available to the County Supervisors, the County Engineer, the EMS infrastructure and, MOST importantly, to the resident whose property is in potential risk-proximity to the erected IWT. That information is not on the website (for the V-110) NOR has been disclosed by MAE despite multiple requests and has been ignored/not pursued by Supervisors or zoning administrators. The Zoning Administrator says it has been "addressed"... but short of actual model-specific paperwork and the manufacturer's appraisal and transparency of potential risk, I would safely state that this request has not been addressed. Once addressed, the public should be able to review the contents of that court-admissible document.

An early 2018 article appeared in the journal, Wind Energy (2018:1-9) co-authored by Scott Larwood from the Mechanical Engineering Department at the University of the Pacific and David Simms from the National Wind Technology Center (NWTC). The authors described concerns about past modeling of blade fragment risk and appropriate setbacks. The purpose of the study was to analyze the risk posed by rotor fragments from wind turbines to roads and buildings as studied at the NWTC. Contemporary sized IWTs from 0.6 to 3 MW capacities were studied. The analysis used a previously developed model for the blade fragment trajectory and the associated probability of impact around the turbines. This study, from a university engineering department in conjunction with a Wind Energy consultant at a national IWT testing center made the following conclusions and recommendations.

- 1) a setback of 2 times the overall turbine height (hub height plus rotor radius) to a **property line** resulted in a "routine risk", which would "probably be adequate" for public safety.
- 2) a setback of 3 times the overall turbine height resulted in a **probability of impact with a dwelling that would increase the risk "above routine"**. Therefore, a setback of 3.5 times the overall turbine height

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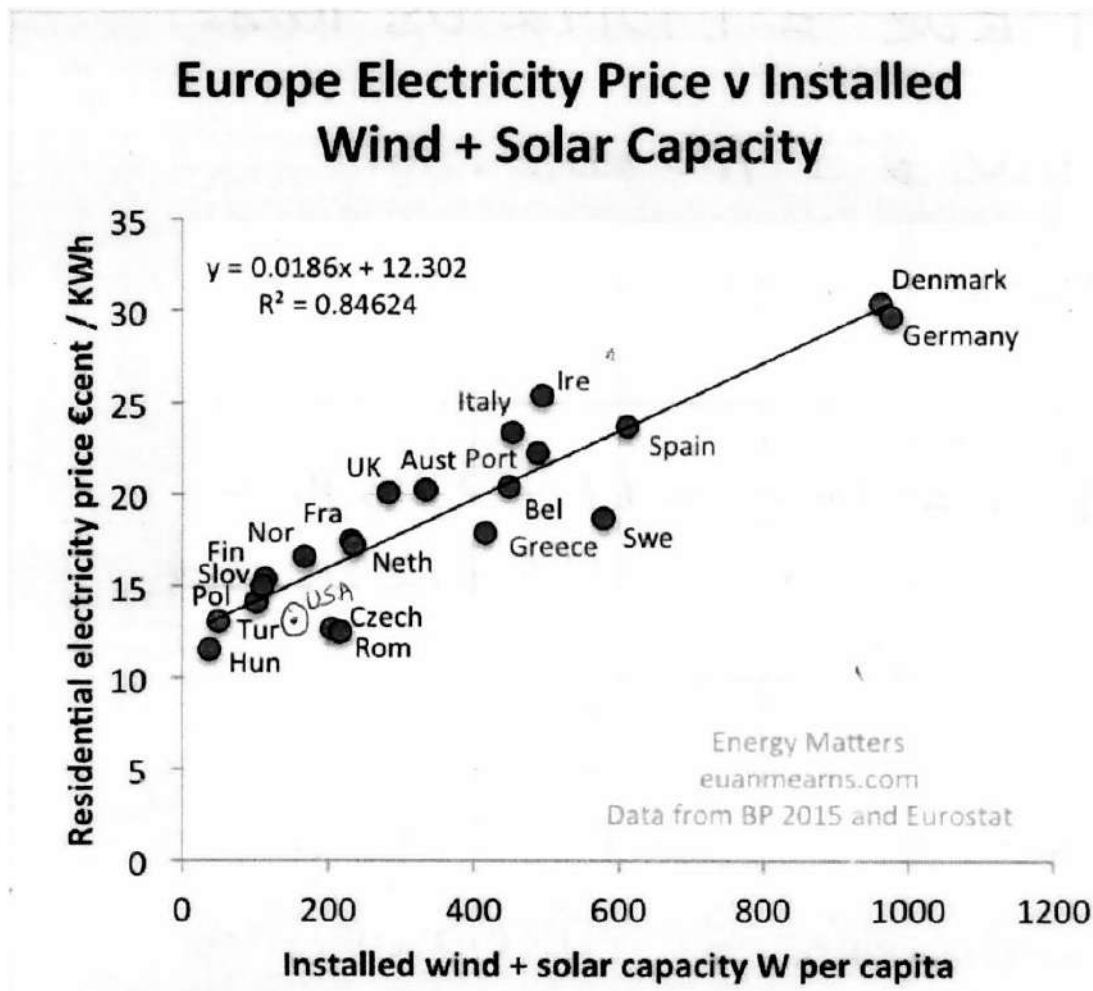
is proposed to lower the risk.

It would seem appropriate to incorporate both of these setback recommendations that were formulated with engineering principles and a goal to achieve more optimal public safety. The modeling they used reflected current technology "standards" of constructing/erecting and maintaining IWTs and reflect needed and appropriate risk vs benefit analysis to best promote citizen safety.

Mr. Clifton's current recommendation of 1.1 times height to the property line and 3 times height to a residence ignores non-participating property rights of the adjacent property owner and is inadequate to protect human safety and land use operations. In addition, it violates the intrinsic value of the property to future development or sale by the owner. This author sees the recent erection of several IWTs "nearly immediately" adjacent to (on the south side of) I-80 (inside of Adair county), between Earlham and Stewart, as also creating great potential risk to the public in the event of a turbine failure. I have also seen many other IWTs placed with inappropriately (my appraisal) close approximation to active roadways around the State of Iowa. I have also seen "still" turbines with a missing blade "broken off near the hub" as well as pictures of nacelles/blade components on fire.

**Apparently, it is acceptable to ignore science when it might impact Wind Energy Industry/Contractors' financial gain. I can see no other reasoning that would allow/incentivize such "reckless" turbine placement. The public expects and deserves protection from massive towers associated with large-scale kinetics that they literally know nothing about. IWT deployment should reflect best current science and highest safety concerns. Because we have failed to protect the public in the past does not mean we should continue those potentially unsafe practices.**

Note European "equalized" relative energy pricing for combined solar and wind renewable sources from 2014. Highest penetration of renewable energies is in Denmark and Germany. The relative positioning of the U.S. is located along the lower left portion of the "line". The correlation of this association is remarkably "robust" with a R-squared value of 0.85. The current subsidies for renewable resources have, so far, protected the cost of electricity in the U.S. Future "plans" are for disappearance of subsidies that will likely dramatically raise energy prices and push U.S. prices toward eventual price tripling if Renewables become more prevalent.



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**Part – 8: Peer Review**

It is amazing that this impasse of strongly conflicting opinions about the safety of IWT exposure has lasted so long. Truly amazing. Especially when:

Wind Energy denies the relevance... essentially the existence of ILFN

They produce "peer reviewed" papers that are somehow a reflection of our country's greatest wisdom. Those papers do cite papers that were peer reviewed - all 4 or 5 - but the MAE paper provided (as reflected by the copy I was given) was never published nor presented in a major meeting or congress where it was judged for its merit and never exhaustively contrasted both sides of the argument. There was no mention specifically in the "paper" of the exact process of the purported "peer review". Indeed, there was no medical review of the contents.

I have included a considerable amount of information in the "conclusion" part that highlights the lack of supportive scientific principles that pervade the comments and quality of Wind Energy's arguments.

**The Investigative Review Board (IRB) Process to Prove "Safety"**

I believe it is the Duty and Obligation of Wind Industry/Turbine Manufacturers to prove the safety of their products. This information should be made available to the public with safety setbacks based on medical and engineering research. They have never done that and the potential for human harm continues to increase.

Industrial Wind Turbines have never been shown to be safe for people or animals/natural environments. There have never been in-depth clinical trials examining populations of exposed humans with repeated biometric evaluations and comparing those findings with matched controls.

An IRB (Investigative Review Board) is a type of committee that reviews the methods proposed for research to ensure that they are ethical. Industrial wind turbine placements into potentially harmful proximity to humans has never had a formal IRB-approved research protocol with monitored research of these turbine. IRBs often conduct some form of risk-benefit analysis in an attempt to determine whether or not research should be conducted. The purpose of the IRB is to assure that appropriate steps are taken to protect the rights and welfare of humans participating as subjects in a research study. Although IWTs have been "around" for 20+ years, they have never, to my knowledge, been "proven/shown/intensively evaluated for safety" in other countries such that those prior "studies" could be reviewed for the methodology, statistical analysis, quality of data and that they adequately support the conclusions.

Having personally been a past member and Chair of the Des Moines Area Hospitals Investigative Review Board for 15 years, I have seen the process unfold innumerable times where a study is presented by the principal investigator for his personal project or by the primary investigator for a regional or national study. The study design and endpoints as well as detail descriptions of the methods are presented. Included also are past relevant research and findings that form the basis of the submitted research

request. Board members (physicians, nurses, pharmacists, administrators, at-large community members, clergy and others have had time to review the submitted documents, highlighting areas of needed discussion and who have felt that the trial design is ethical, come to a meeting where the investigator verbally presents the study and then responds to questions from the Board. Particular focus on the completeness of the process/documentation of informed consent is done at that time. If reasonable, the study is approved and implementation of protection of human subjects is carried out by the IRB for the duration of the study.

In some studies, a data monitoring committee is available (particularly with large studies and where unknowns exist or where potentially serious adverse effects may come to light). This DSMB (Data Safety Monitoring Board) is an independent group of experts who monitor patient safety and treatment efficacy data while the trial is ongoing. Should concerns be raised through evaluation of requested review of singular "adverse events" or at pre-specified periodic data review points, the DSMB has the obligation to stop the trial and request further data or initiate further adverse event reviews before the trial is restarted.

It is remarkable that (to my knowledge) no IRB oversight has ever been done given the concerns about potential adverse health effects to humans. It is likely to never be done in a complete and formal way. The least that should be done is that there is an "independent" (free of pro-/anti- wind bias) board that should be in charge of soliciting and recording events. If such events appear to be "anomalous" (deviating from what is standard, normal or expected), then formal evaluations to explain those observation should be mandated. Such evaluations should be well funded and able to have access to whatever scientific scrutiny is warranted. Metrics for assessment of AHEs would need to be clarified, be acknowledged as "scientific", be funded by the manufacturer among other significant considerations. Yes, there is cost and bureaucracy involved but discovery, clarity and truth determination can be hopefully achieved. It is my opinion that the federal government continuation to subsidize these "unknown risk entities" puts America on an unknown course for climate security, resident health, safety and welfare security and delays safer, more reliable and sustainable energy production.

### **Causality**

Although Wind Energy has never, nor ever attempted, to prove that industrial wind turbines are "safe", they continue to rebut increasing amounts evidence that IWTs pose a risk to human health. They commonly use the phrase "there is no credible evidence" as a means to "sanctify" their statement with an implied absolute certainty that IWTs are, in fact, safe. Instead, their statements fail to acknowledge that "causality" in epidemiology can never be completely proven. Causality is a "gradual term" for which evidence is

- 1) increasing with increasing number of facts
- 2) supported by the magnitude of effect
- 3) supported by a dose-response relationship

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4) consistent with other studies in different populations

5) consistent with different study methodology

6) supported by biological plausibility

Indeed, the data that IWTs actually cause adverse health effects exists and lends support to all these tenets.

Sir Austin Bradford Hill, Univ of London shared his thinking about association and causal evidence surrounding environmental disease. He posed nine elements that are critical in establishing causation: **Strength** (of observed relationships), **Consistency** (or repeatability of relationship based on observations by different persons, in different places, under different circumstances and at different times), **Specificity** (causation is indicated if the associated is limited to specific individuals and to particular sites and types of disease and there are no associations with other factors), **Temporality** (there is a clear temporal relationship between outcomes and periods of exposure and non-exposure), **Biological Gradient** ( a dose-response relationship exists), **Plausibility** (causation is more likely when certain outcomes are biologically plausible, or possible, a caveat being that plausibility depends on the biologic knowledge of the day; this element is best expressed in the statement: "when you have eliminated, whatever remains however improbable, must be the truth), **Coherence** (the cause-and-effect interpretation of data should not seriously conflict with generally known facts of the natural history and biology of the disease), **Experiment** (experimentation or semi-experimental evidence, even if only occasional, can reveal the strongest kind of evidence for causation, and **Analogy** (the recognition that similar cause-effect relationships have occurred under similar conditions).

In corresponding with Professor Punch, he also agrees that all 9 elements that Sir Hill has itemized to support causality are met as written below in a recent expert commentary request for the Neosho Ridge Wind Project in New York:

*With respect to the nine Bradford Hill criteria, all have been identified in the scientific literature as pertinent to the relationship between IWT noise and AHEs. The respective analogies are: (1) widespread reports of complaints, (2) consistency of reported symptoms, (3) and (4) concurrence of symptoms with IWT operation, (5) a dose-response relationship between exposure levels (or distance) and symptoms, (6) the role of disturbances of the hearing and balance mechanisms of the inner ear in causing identified symptoms, (7) coherence with WHO, U.S. (federal), and some state noise guidelines, (8) in addition to cross-sectional studies, experimentation is established by the fact that symptoms decline or disappear when receptors leave the area and recur when they return to the area, and (9) noise-induced Sick Building Syndrome.*

Sir Hill noted that "all scientific work is incomplete - whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. But that does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time".

Importantly, when we consider

- 1) The strength of the data presented by Wind Energy as "lacking" robust data
- 2) The absence of any data from Wind Energy to prove that IWTs noise emissions are "safe"
- 3) Enormous amounts of increasingly supported and complementary data correlated IWT noise to adverse health effects

One must make a decision if there is or is not a true association of wind turbine exposure with adverse health effects. As just written above: Sir Hill recognizes that all scientific work is incomplete, but that does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time.

Wind Energy's stance of "proof" is grossly less than the mass of supportive materials presented in this review. By comparison, in a 2015 "scientific supportive" **opinion** of existing data (not their original data), the Council of Canadian Academies reviewed available data (journal articles, web pages, legal decision and non-peer-reviewed publications on wind turbine health effects. Their reviewed agreed that evidence was sufficient to establish a causal relationship to annoyance, limited evidence for a causal relationship to sleep disturbance but was inadequate to determine if there was a link to stress and other health outcomes.

Although I cannot find evidence that the summary of their opinions was ever "published" in a scientific journal where independent journal review occurs, the results were initially made available on their website. They made reference to the fact that they "used" some of the principles of Sir Hill's elements to support causality (which I listed above), but did not explain the results in terms of tallies of supported principles or their conclusions. They said that the article was "peer-reviewed" by "an entity" that preferred to remain anonymous. I am told by testifying experts familiar with the literature and arguments over several decades, that there was great outcry about the posted article contents and the article was subsequently taken off the website. I personally tried to contact (by phone) the Academy. The phone rang several times, was picked up (electronically?) and was disconnected. So much for "scientific rigor" – unexplained methods and results, unpublished in independently reviewed journal, reported was peer-reviewed by an anonymous entity (worthless excuse) and the original publication cannot be found on the website because it was reportedly "taken-down" due to criticisms of apparent "inadequate" scientific process.

Although mentioned elsewhere in this large statement, given the content and direction from Sir Hill, it is good to include here the comments by Mathias Basner, MD, PhD who personally reviewed and helped to summarize the data for the Oct, 2018 WHO environmental Noise Report. In a 2019 editorial he acknowledged the problem of smaller populations in currently available studies which makes statistical powering of conclusion difficult. (This is exactly the problem with study IWT noise and its production of adverse health effects on nearby residents). He stressed that NONE of the wind noise guideline data



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from the 2018 WHO report found an "absence of risk". He finished his comments with "the fact that more studies are needed should not lead us to postpone the urgently needed protection of the population from noise. The knowledge we have acquire so far IS SUFFICIENT to take preventative actions and substantiate them with respective legal noise regulation - that is exactly what needs to be done with the Madison County Wind Ordinance. I will later repeat this.

Adverse Event Reports: Taken from (Carl V. Phillips, "Properly Interpreting the Epidemiologic Evidence about the Health Effects of Industrial Wind Turbines on Nearby Residents" Bulletin of Science, Technology and Society, vol 31, No 4. August, 2011, P303-315). Epidemiology is the study of health outcomes and their causes.

"There is overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder type disease, at a nontrivial rate. The bulk of evidence takes the form of thousands of adverse events reports. Proponents of turbines have sought to deny these problems by making a collection of contradictory claims including:

Adverse effect reports don't count

The outcomes are not "real" disease

The outcomes are the victim's own fault

Acoustical models cannot explain why there are health problems so the problems must not exist

These claims appeared to have swayed many non-expert observers, though they are easily debunked. The WHO has described annoyance as a critical health effect - associated with stress, sleep disturbance and interference with daily living. Moreover, though the failure of models to explain the observed problems does not deny the problems, it does mean that we do not know what, other than DISTANCE, could sufficiently mitigate the effects. There has been no public policy or law that justifies imposing these effects on local residents and upon their private properties. The attempts to deny the evidence cannot be seen as honest scientific disagreement, but rather, represents either gross incompetence or intentional bias.

### **AWEA/CANWEA Report into Turbine Sound and Health**

Wind Energy on their promoting websites, has listed the "AWEA/CANWEA" (American and Canadian Wind energy Associations) Report into Wind Turbine Sound and Health, December, 2009 "supports" the safety of IWT deployment. Dr. Malcolm Swinbanks during his March 2015 his expert testimony before the Australian Select Committee on Wind Turbines described that report to "represent the first study to bring together experts from the acoustics community and the medical profession, to examine the nature of adverse health effects associated with wind turbines. As such, it has been widely quoted and has very much defined a perspective which continues to prevail in subsequent, similar studies".

He described two important observations: (He also reminded his audience of his early career experience on the active sound control of industrial gas turbine compressors in the early 1980s in a rural

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environment... he found it "quite striking" that some expert reports fail event to mention these two important effects).

1) "it completely failed to take account of two of the most important aspects of low-frequency and infrasound perception. Specifically, there is no mention of the fact that the threshold of hearing automatically adjusts to the background ambient sound level, with the result that infrasound levels in cities and suburban areas are well below the threshold and completely imperceptible, where in quiet rural areas, the much lower hearing threshold enables adverse effects from wind turbines to be perceived. Consequently, dismissive arguments which directly equate infrasound levels in these two very different environments without taking into account these significant differences in perception are fundamentally flawed.

2) "the report also fails to mention that continued exposure to low-frequency noise and infrasound can result in progressively more acute physical sensitivity to the sensation and effects.

The ACWEA Review was also critiqued by the Society for Wind Vigilance. Some of their comments:

1) The conclusions of the ACWEA Panel Review are not supported by its own contents nor does it have convergent validity with relevant literature.

**2) The ACWEA Panel Review acknowledges that wind turbine noise may cause annoyance, stress and sleep disturbance and that as a result people may experience adverse physiological and psychological symptoms. It then ignores the serious consequences of those AHEs.**

3) Despite the acknowledgement that wind turbine noise may cause annoyance, stress and sleep disturbance the ACWEA Panel Review fails to offer any science- based review that would mitigate these health risks.

4) The ACWEA Panel Review can only be viewed for what it is. It is an industry association convened and sponsored attempt to deny the adverse health effects being reported.

The ONLY effort made by Wind Energy (locally represented as the Iowa Environmental Council) to provide scientific proof supporting their stand that IWTs do not cause adverse health effects to Madison County residents was in their hand-out entitled "Wind Turbines and Health".

Ms. Kerri Johannsen stated that she wrote the article and that it was peer-reviewed. The title inferred a detailed review of the topic of health concerns associated with industrial wind turbines; there were only 4 papers that were referenced. There was no date of publication on the paper, nor reference that it would be submitted for publication. There was no documentation of any formal peer review having been performed on the article nor any verbal description of the peer review process by Ms. Johannsen; there was no mention of an ethics board, a publication board or any specific entity that actually reviewed the work and the merits/support of the conclusions. There were no references to any World Health Organization and that organization's focus and concerns about environmental noise and sleep disturbance (which is the major health concern about turbine noise). A large part of the paper is

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focused on the subjective concept of negative perception of industrial wind turbines as the nocebo effect. This is the concept of a detrimental effect on health produced by psychological or psychosomatic factors. This idea is discussed in the first topic of Part - 7.

It appears to me that the peer review process claimed by Wind energy is frequently an informal review done by individuals sympathetic to the pro-wind agenda. One cannot expect other scientists to take seriously an organization that refuses to accept nor comment nor attempt to objectively refute, well-supported, "conflicting (to Wind Energy)" scientifically based research. If Wind Energy does not like the conclusions by well-respected investigators, they simply ignore it. Wind Energy continues to insist on unreasonable and unachievable strengths of evidence that are simply "not attainable". More importantly they have not produced any research that proves they are safe by those same "unattainable levels of causality" while a great majority of the rest of the scientific community does believe that a causal relationship, based on the available evidence, does exist.

I have included a copy of a February, 2005 British Wind Energy Association "briefing sheet" on low frequency noise. Although now 15 years old, their public stance has not changed. It is notable that several of their "facts" have been disproved. In the conclusion, they mention that the "main" effect (on humans) depends on the listener's reaction to what they may hear (nocebo effect). (Writer's comments: They imply that all wind turbine noise lies below the threshold of perception - all of which has been discussed as incorrect in the contents of this review (yet no subsequent, more recent statement from Wind Energy acknowledging that science has led us to know that it is perceptible to some degree and can be annoying and can contribute to serious adverse health effects including sleep disturbance and may be causal for serious cardiovascular health consequences). The final statement (by G H Levanthall - whom I have mentioned many times) read: "I can state quite categorically that there is no significant infrasound from current designs of wind turbines". When I looked for the precise definition of "categorical", I found "something that is absolute or without conditions..." Looking at that definition then back to his statement then reflecting the enormous amount of information I have reviewed, I feel comfortable stating that "I am categorically certain that his statement is false and "actively misleading".

On 6/28/2020, I reviewed the American Wind Energy website looking for their "claims" about health effects. I went through several layers of "glossy promotional information" and eventually found some information related to health effects. Several bullets under "sound" were reviewed. (In my opinion) nearly ALL of the statements were incorrect or misleading. The details of ILFN, or noise perception thresholds are absent. There is no information about annoyance, home evacuations, sleep disturbance or cardiovascular disease. The site mentioned a "Massachusetts study and a major study in Canada" but we have no further references search tools to find the data and verify their statement as not being taken out of context or being correct in the first place.

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Part – 9: Searching for an Explanation Why Harm is Acceptable- A View of the "The Dark Side" of  
Wind Energy - Behind the Scenes.....Promoting their Vision

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**Attack on Science Leader who spoke the truth**

Wind Energy (as a faceless faction) has been quite critical of research and statements made by notable and authoritative scientists and university faculty. As an example, one of the most premier acousticians in Europe was Dr. Henrik Moller of the Aalborg University, Denmark. He was the head of the Acoustics branch and fully tenured. He wrote a paper saying that larger wind turbines will result in increased low frequency sound. As a result, Wind Industry demanded that his funding be revoked and that he be expelled from the University. He lost his position over his research due to politics and the power of the Wind Energy business in Denmark (likely Vestas).

**Wind Energy Self-Protecting Ordinance Writing**

The same Dr. Henrik Moller from Denmark and his team of acousticians had been consulted by the Danish Environmental Protection Agency regarding new regulations to limit low-frequency noise generated by wind farms. A new limit of 20 dBA was established to limit sound levels in the 10-160 Hz range. It was designed originally to impose the same limits on wind that are enforced on other industry that produce ILFN. The problem with the wind ordinance was that sound insulation varied considerably with different home standards. From that insulation value, the ordinance had to obtain the calculated indoor noise levels and, as such, higher calculated indoor levels would be accepted in lesser insulated homes. It appears that the "absolute limit" at 20 dBA was not absolute. It was originally passed by the Danish authorities ignoring protests from the Wind Industry. The CEO for Vestas, had in a letter to the Minister of the Environment, warned against plans to introduce a low-frequency noise limit for wind turbines. It would create problems for Vestas's most economical model in the 3 MW class in open landscapes, **since it would be impossible to further reduce the noise within the existing technology.** I have included a letter from Vestas to the Minister of the Environment, dated 29 June 2011 for your review. This letter reflects a strong disagreement about further restricting the limit of low-frequency sound. As you read the letter, you need to endure their self-promotion and their sense of being persecuted rather than acceptance of what the government had requested to protect residents. Subsequently, they were able to "work out a deal" as described below that essentially negates their concern of not being able to meet new sound limits that specifically designed to increase resident health safety. It continues below:

Out of consideration to the Wind Industry, within the apparent original bill, there was a "political requirement" that the limit for low-frequency noise could never "curtail or limit" the building of IWTs. Apparently, from the beginning of planning the bill, Wind Industry was strongly represented in the work on the revision of prior regulations and they had great impact on the final result. At an initial meeting, there were nine people in attendance - including five from the Wind Industry. The other three were acoustical consultants with close connections to the Wind Industry. The Danish EPA had one

representative (Jakobsen) who worked out the minutes. According to the minutes, Jakobsen found that 20 dBA would be fine but "it depends on the main goal: namely that the new limit does not set new obstacles for wind turbines". In the meeting it was agreed that noise should not be measured indoors in nearby houses; sound measurements would be calculated using an uncertain model and using insulation data from the Wind Industry. It turned out that with the insulation values, 75% would exceed the limit. In addition, complaints could NOT be voiced. The main responsible politician for this "new limit" was the Minister of the Environment. **Dr. Moller also commented** that all the (accepted) errors and insulation "exceptions" produced almost a 10 dBA rise over the original 20 dBA limit. He noted that at such low frequencies, "the perceived intensity or loudness, increases more steeply above threshold than at higher frequencies. This means that when the level is a few decibels above the 20dB limit, the consequences are more severe, than if a limit for higher frequencies is exceeded by the same amount. Moller commented: **"Few people would probably accept 25 dBA in their home at night and hardly anyone would accept 30 dBA". Duchamp, the Executive Director for the European Platform against Wind, commented: "It would appear that the Danish authorities have been cooking the figures to accommodate the Wind Industry. Years ago, governments were protecting tobacco companies; today, they absolve wind farms of all sins and help them commit more".**

**Wind Energy: Declaring "Fact" through Misuse of Standard Acoustical Instruments**

Previously and repetitively mentioned, is Wind Energy's reluctance to admit that infrasound is present in the noise emissions and is responsible for blade harmonics (and other perceptible emissions) that contribute to resident's annoyance suffering which then contribute to adverse health effects. It would appear they recognize the key "threat" to their narrative that IWTs do not cause AHEs should they acknowledge health impacts produced by ILFN.

In the early 2010 era, Wind Energy claimed that infrasound from IWTs was either non-existent or if they admitted that they found it, they would compare to the levels of other common sources of infrasound to conclude that wind turbine ILFN was lower than what already exists in many communities. Notable acousticians from the engineering firm, Epsilon and Associates (known for their close relationship with Wind Energy) had published earlier, in the same venue, "Noise-Con 2010, April 19, 2010" the article "Low Frequency Sound and Infrasound from Wind Turbines - a Status Update". They introduced their position in this paper commenting on the "argument" of whether IWTs created unacceptable levels of low frequency noise and infrasound. They performed a "world-wide" literature search to determine unbiased guidelines and standards used to evaluate low frequency sound and infrasound. They also performed a field study to measure wind turbine noise outside and within nearby residences. They compared their findings with guidelines and standards from ANSI S12.2 for interior sounds and ANSI S12.9, Part 4 and some European criteria, for thresholds of annoyance. They concluded that "there should be no adverse effects from infrasound or low frequency noise at distances greater than 305 meters from wind farms. They referenced a recent Dr. Leventhall article that presented "an excellent and comprehensive study on low frequency noise from all sources and its effects". They commented that the U.S. government does not have specific criteria for low frequency noise. They used Moller

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pure-tone ILFN hearing thresholds and made octave band analysis - (both of those acoustical standards have since been shown to be inaccurate and inappropriate for use in the infrasound spectrum).

Fifteen months later, another report (Bray and James) "corrected" the Epsilon consultant assumptions. (Writer: Simplifying their comments), they noted that quantitatively describing the sound pressure levels of infrasound emissions content cannot be accurately performed using the traditional methods of frequency analysis from octave or one-third octave band analysis. Those tools are built into almost all professional grade sound instruments. The current filters are digitally simulated versions of the resistor-capacitor filters used in early pre-digital sound pressure level meters. The newer, digitally-simulated version require that the sound being measured is **steady over the period of time required to saturate the filter**. For frequencies above 20 Hz filter, saturation times are only a few hundred milliseconds. In stark contrast, to measure the sound pressure level at 1 Hz, to reach 90% filter saturation, the filter must be steady for 4989 msec (almost 5 seconds). IWT infrasonic pressure pulses last about 10-20 msec. Measuring sound of low frequency content with a short 10-20 msec pulse to a filter means that the filter never reaches 90% saturation - not even close. Thus, sound pressure levels that are "outputted" by the filter are all artificially much lower than they really are. The lowest 1/3 octave band sound pressure filter that can accurately measure a 10 msec pulse is 500 Hz. This information describing filter saturation times is found in "appendix 2" at the end of the Article: Noise-Con 2011, July 25, 2011 "Dynamic Measurements of Wind Turbine Acoustic Signals, Employing Sound Quality Engineering Methods Considering the Time and Frequency Sensitivities of Human Perception" and was written by Wade Bray and Richard James - both independent acoustic consultants in the U.S.

The proper analysis of infrasound pulsations, as opposed to steady infrasound, is to make a high-quality recording using a digital recorder and an infrasound-rated microphone. The recording is analyzed using methods based on Fast Fourier Transformation (FFT) which can convert a time domain signal into its frequency domain sound pressure levels without the use of digital octave or 1/3rd octave band filters like the majority of professional sound levels meters use. This is described in the ANSI S12.9 Part 7, Appendix D. The main part of the "Part & Standard" works very well for infrasound that is reasonably **steady over time**. However, the short pulses from the blade-tower interaction (10-20 msec duration pressure pulses) will be dampened by the filters as if being averaged, and, depending on the ratio of on-to-off time, will be much lower than the true peak level (which is what we perceive). We feel the peaks or crests of the pressure waves. We do not feel the average of the sound over the period it takes for a digital filter to fully saturate.

In multiple subsequent legal hearings over the years, Rick James has recurrently made this point with offering the data of Appendix 2 as evidence... eventually Wind Energy stopped citing their original incorrect information. Despite the eventual acceptance by Wind Energy of their "flawed assumption at many levels", it is of interest that a Madison County resident during a private conversation with a Wind Energy representative in Madison County (early in the course of MAE's efforts), was again told that IWT infrasound noise levels are less than environmental background levels.

"Normal" People don't

Run from the facts ... or, simply not comment

Conveniently ignore the truth

Demand ABSOLUTE Causality when very little in the world can be "proved absolutely".

In a remarkable speech, Dr. Mauri Johansson, MD, MHH, a specialist in community and occupational medicine, delivered a speech at the general meeting of Vestas on Thursday, March 29, 2012 in Denmark. Previous to and after this speech, he has been active in the area of describing adverse health effects created by wind turbine exposure.

A copy of the translated speech is this Part's appendix.

It has become apparent to me that there is a huge worldwide deception in play. "How can this level of deception exist?", I asked to many (un-named) who have been witness to this business for the last 40 years. Their collective response: "(I) see it in many businesses, especially in the unregulated utilities that are multinational. It is a business model for large firms... through PR firms, lobbyists and outright control of our country's politicians and courts...together work to make themselves richer and immune to citizen oversight".

We have to understand the goals of Wind Energy

and their messengers and the rehearsed presentations

and their hiding behind their hollow arguments of their "science"

and their workings without empathy, or concern ... failing to hear the  
cries of victims of their manufactured oppression

They (must) struggle violently to believe they are in the right and  
that "we" are incapable of understanding their (misguided) insights and  
righteousness

It is not green, sustainable, renewable nor humane... it is  
not the answer.

This section reveals the extent to which Wind Energy has gone is the past and continues to the very present to champion their industrial wind turbines. The "Non-Wind", i.e.-Health science is better,

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more accurate and more complete. The most accurate science that their Wind Energy's acousticians have produced were done by Dr. Leventhall prior to 2004. After that, having become a champion of Wind Energy, those "correct" initial interpretation of ILFN were ignored (but not publicly disputed) by Dr. Leventhall. Once "captured" by Wind Energy, "they" worked together to bring their version of infrasound to the nations of the world that would absolve them of willfully "harming" the recipient residents. The ETSU-R-97 was contrived by a large group of pro-wind supporters (and complicit governmental ministers who adopted the guidelines that brought commerce and the illusion of clean power to the U.K. and then was later spread to their colonies and eventually to the U.S. (in the vacuum of federal oversight) with pseudo-science that allowed loud audible sound and hence also louder infrasound to be produced at night to levels over 20 dBA above background - among many other non-science supported assertions.

Wind Energy worked hard to control the narrative particularly when they recognized that they could engineer and produce larger sized IWT with higher energy-producing capabilities. They pressured universities to silence world-acclaimed acousticians who correctly correlated increased IWT size with higher IWT noise emission level in the ILFN spectrum - creating more potential harm to more residents and at farther distances.

Vestas badgered their own government to lessened sound limits on low-frequency noise, then were able to circumvent it through political means.

Vestas badgered the Australian government with incorrect narrative of anti-wind activists and the harmlessness of infrasound

Dr. Johansson saw through their business plan carefully obscured by sanctifying corporate appearances and hollow assertions. It should become much more apparent of what is happening then as is now as one reads his clear distillment of Vestas' real interests. Please read the speech text included in the appendix.

It should surprise no one that the Chairman of the Board of the American Wind Association is leader of the North American Business Unit for Vestas.

These comments are my opinions. I have provided documentation where able. I believe I have made conclusions (included herein) that are reasonable and could be considered as such by a reasonable person. I have fact-checked and cross-checked as best I can. I believe this section's commentary and evidence are crucial for a reasonable person to better understand Wind Energy's Stance on adverse health effects from IWTs.



Click on file below to find 2005 British Wind Energy 2-page informational sheet on their “views” about infrasound noise component in IWTs



2005 Low  
Frequency Noise an

Below finds excerpt from American wind energy website on their position about adverse health effects arising from IWT noise. Note no data, references to data, just unsupported conclusions.

**THE TRUTH:** Independent studies conducted around the world, including the U.S. have consistently found **no**

www.aweablog.org/the-truth-about-wind-power/

3/7

8/2020

The truth about wind power – Into the Wind

evidence that wind farms cause any negative physical health effects.

- Typically, two people can carry on a conversation at normal voice levels even while standing directly below a turbine.
- Thousands of people worldwide live near wind farms with no ill effects.
- Emitting virtually no air or water pollution, wind energy is essential to reducing energy-sector public health impacts.
- Studies and government health organizations around the world have given wind a clean bill of health. For example, a **Massachusetts study** found no evidence for a set of health effects from exposure to wind turbines or for the existence what some have tried to characterize as "Wind Turbine Syndrome."
- A major study in Canada of over a thousand homes confirmed this again, **stating**, "No evidence was found to support a link between exposure to wind turbine noise and any of the self-reported illnesses."
- Studies have found that a "**nocebo**" effect can take place, the opposite of the well-known "placebo" effect. The nocebo effect describes a situation in which individuals who are led to expect physical symptoms may actually experience these symptoms, whether or not the supposed cause of the symptoms is actually present. In this case, increased exposure to misinformation about wind actually seems to increase the likelihood that certain individuals will report negative health effects such as headaches or nausea, although no scientific evidence shows wind turbines cause any such health effects.

Danish Physician Mauri Johansson Addresses Vestas Corporate Meeting about need to focus on health safety for potentially affected residents. It is sobering, incredibly insightful and the message is still relevant today.

This can be opened and reviewed below:



Doctor blasts  
Vestas at Board mee

The PDF document below was opened and printed below. The PDF filed is also available to be opened to see original letter format. This 2012 document reflects Vestas' objections to the introduced potential "safety-related" restriction proposed for Wind Energy. Toward the end, they minimize concerns about low-frequency noise.



12-03-14 Vestas in  
AU requests removir

14 March 2012  
Policy, Planning Systems and Reform  
NSW Department of Planning and Infrastructure  
GPO Box 39  
SYDNEY NSW 2001  
By email: [innovation@planning.nsw.gov.au](mailto:innovation@planning.nsw.gov.au)  
Dear Sir/Madam

**DRAFT NSW PLANNING GUIDELINES: WIND FARMS**

Thanks you for the opportunity to make a submission on the *Draft NSW Planning Guidelines: Wind Farms (the Draft Guidelines)*.

Vestas Australian Wind Technology Pty Ltd is the local subsidiary of Vestas Wind Systems A/S, the world's largest manufacturer of wind turbines.

Vestas is the world's leading supplier of wind power solutions, having installed more than 41,000 wind turbines across the globe. Worldwide, Vestas employs more than 23,000 people in the design, manufacture, sales, installation, operation and maintenance of wind turbines.

While the home country of Vestas is Denmark, we have significant operations all across the world and we are experienced in comparing policies and regulations in all our markets.

In Australia we have been responsible for the supply of more than half of the wind energy capacity to date. However Vestas is not a developer or owner of wind farms or wind energy projects, and so does not seek planning permits.

Vestas is also a member of the Clean Energy Council (**CEC**), and in addition to our own submission we would also refer you to the CEC's submission regarding the Draft Guidelines.

**Executive summary**

Vestas opposes the Draft Guidelines, primarily because of the sheer number of new and additional requirements and barriers that would be placed in front of the wind energy industry without any clear evidence, justification or demonstrated need for this additional regulation.

The Draft Guidelines appear to be in conflict with the New South Wales (**NSW**) Government's own renewable energy policies and seem to be primarily motivated by an attempt to appease anti-wind protest groups.

The Draft Guidelines impose new rules that are not faced by any other industry in NSW, and directly discriminate against wind energy.

Some concepts, such as the requirement to assess impacts on property values and the introduction of a 2km "gateway" are at odds with many years of existing case law in the planning portfolio.

Other concepts such as the new noise requirements are more stringent than any other jurisdiction in the world, without any justification as to why this is required.

Even though we suspect the Draft Guidelines have been drafted in response to the lobbying of anti-wind activist groups, we confidently predict that the Draft Guidelines will not be accepted by those groups.

Such groups are not interested in compromise or balanced outcomes. They care little for evidence-based policy or addressing genuine impacts that wind farms might cause in specific locations. They seek nothing less than the demise of the wind farm industry, wherever it may be located.

Unfortunately, higher electricity prices will be the legacy of this attempt by the NSW Government to appease a noisy minority of activists. In addition, job growth and investment attraction will also suffer.

This will occur because the additional requirements and barriers in the Draft Guidelines for wind farms will make them more expensive to build and operate, and will force them to be located in areas where wind speeds are lower or transmission access is harder to secure.

By contrast, South Australia provides a good example of how a state government has worked with the wind industry and local communities to attract investment and jobs, build record levels of wind farms and keep power prices low. NSW would do well to follow this example and ignore the small but noisy group of activists that are seeking to destroy the wind industry and keep NSW reliant on fossil fuels.

### **Background**

Over the past decade in Australia, the wind energy industry has grown substantially in almost all states and territories, to the point where more than 2000 megawatts of installed wind capacity is now operating. A further 6000 megawatts of new wind energy projects are currently being investigated or are in the planning stages, many of them in NSW.

Part of the reason for the industry's growth has been the Federal Government's 20% Renewable Energy Target (**RET**) scheme, which has driven most of the investments in wind energy in Australia since 2001. The decision in 2009 by the Australian parliament to lift that target to 20% by 2020 will continue that growth over the next decade.

The other key driver behind this growth has been the policy imperative for all nations around the world to cut greenhouse emissions in an effort to reduce the impact of climate change. Wind power is the most cost-effective form of renewable energy with zero greenhouse emissions, and is forecast to retain this status for many years to come.

### **Wind energy and its role in energy policy**

Wind energy is just one source of energy available to NSW. Historically, NSW has relied heavily on coal to supply its electricity. While coal has provided low-cost electricity during the previous century, this does not mean that this is likely to continue in this century. Labor costs, extraction costs and pollution costs are all good reasons for NSW to consider moving away from such a heavy reliance upon coal and gas.

In addition, the further expansion of coal mining and gas extraction has been facing increased community concern, particularly from farmers. Coal mining is an activity which is not able to coexist with farming activities in most cases, as it usually entails open cut methods or involves such significant activity at the mine mouth that growing crops or managing livestock becomes problematic, and in many cases impossible in the same location as the mining activity or gas extraction.

In addition, access to water is also a major factor that makes it difficult for coal mining and gas extraction to coexist with farming. Unlike other users of water, power stations often obtain their water at sub-commercial rates and this has been under

challenge in recent years.

The National Water Commission has examined these issues and said electricity generators "should face the full economic costs of their consumption decisions, so they have incentives to invest in more efficient technologies"<sup>1</sup>. Coal-fired power stations use large volumes of water for cooling purposes, so this is no small issue. By contrast, wind energy does not face these issues. Barely any water is required for the operation of wind turbines. They cause no air or water pollution. There are no greenhouse gas emissions from wind turbines. And wind energy, unlike many other forms of electricity generation, does not have a fuel cost.

<sup>1</sup> "Water and the Electricity Generation Industry: implications of use" National Water Commission, 2009

While other states and countries do not have significant renewable energy resources, NSW does<sup>2</sup>. It would be prudent for the NSW Government to focus on diversifying into wind energy over the coming years, which appears to be the approach now being taken.

It has been pleasing to see that the NSW Premier and a number of his ministers have restated their support for the 20% RET and indicated their willingness to attract investment in renewable energy to help achieve the target, including a statement by Planning Minister Brad Hazzard on radio on 9 February this year.

An increase in wind energy generation in NSW is an excellent strategic move in light of water and greenhouse gas constraints, and such a move will also act as a natural hedge against any increase in the fuel costs of coal and gas-fired power stations. Against that background, the proposed introduction of a new and discriminatory set of planning guidelines that makes it more difficult to build wind farms in NSW seems short-sighted and highly questionable given the strategic issues discussed above.

### **Rationale and principles behind the Draft Guidelines**

The Executive Summary of the Draft Guidelines includes the following statement:

*The NSW Planning Guidelines: Wind Farms have been designed to deliver improved consistency and rigour in the planning assessment process and ensure effective consultation with local communities.*

Presumably such goals would also be worthy of pursuing in relation to the planning assessment process for all kind of land use, not just for wind farms.

It is imperative that any proposed changes to the planning assessment process are fair, transparent and efficient.

Assessment of wind farms should be based on objective criteria that all stakeholders can understand.

This can be achieved by ensuring the Draft Guidelines do not place additional burdens on the development of wind farms by creating delays or uncertainties in the planning process.

As is discussed below, many of the provisions of the Draft Guidelines discriminate against wind farm development and should be amended to ensure this discrimination does not occur.

<sup>2</sup> "Australian Energy Resource Assessment" Department of Resources, Energy and Tourism, 2010

### **Specific responses to the Draft Guidelines**

#### **Section 1.2 Which development assessment process applies?**

We note that the minimum 30 days exhibition time for state significant development (SSD) projects has been extended to a 60 day minimum in the case of wind farms that are deemed SSD.

While the duration of this period does not particularly trouble us, the discrimination against one form of development certainly does.

In practice, we would expect that wind farm project proponents would work with local communities, local councils and the Department of Planning and Infrastructure (DP&I) to agree on a longer exhibition time for highly complex projects where this is considered to be necessary.

However, we consider it is inappropriate and discriminatory to entrench a longer exhibition period for wind farms as a blanket rule, and we do not consider that the basis for this decision has been justified by DP&I.

**Section 1.3 (a) Proximity of turbines to existing residential dwellings (2km)**

Vestas welcomes the increased focus on community consultation and engagement in the Draft Guidelines. We also support the requirement to comprehensively document the views of nearby landowners, including any concerns they may have with proposed wind farms.

However, we do not support the requirement to explicitly seek the written consent of all landowners within a 2km range between proposed wind turbines and existing residential dwellings, or the requirement for a Site Compatibility Certificate in the event that written consent is not obtained.

Such a requirement does not apply to any other kind of development to our knowledge, and accordingly it is discriminatory against wind farms without any clear justification for this.

In fact, setting a specified zone for engagement may actually reduce the capacity for wind farm proponents to comprehensively consult with local communities and residents.

In relation to the 2km "gateway" zone, we would note that the 2011 Senate Inquiry into Rural Wind Farms concluded that "the application of scientific measurements for sound and for shadow flicker to alleviate problems for wind farm neighbours may be preferable to prescribed setbacks. Prescribed setbacks are arbitrary and may be too great or too small"<sup>3</sup>.

That statement is consistent with existing case law. The 2010 decision of the NSW Land & Environment Court on the Gullen Range Wind Farm rejected the local council's proposal of an arbitrary setback distance of 2km, stating that "assessment of impacts on properties should be done on an individual basis taking into account topography, orientation of houses and distances to visible turbines"<sup>4</sup>.

It has not been made clear by DP&I why NSW should now move away from established law as well as the findings of the Senate Committee. It has not been made clear why wind farms should be subject to this discriminatory form of assessment compared to every other kind of land use.

If it was thought by DP&I that a 2km zone would go some way towards appeasing the various anti-wind groups from the constant political campaigning against wind farms, it won't work. The stated goal of the anti-wind activist groups is to have a 10km buffer zone between residential dwellings and wind turbines<sup>5</sup>. They continue to claim that wind farms cause direct and adverse health impacts, even though the peerreviewed evidence on this topic indicates the exact opposite.

In addition, there are practical concerns regarding the very early stage at which landowner consent is required. When developers are investigating sites, various technical aspects are simultaneously investigated including wind resource and planning constraints. This process can take months during which community

consultation will be taking place. However, the developer is unlikely to know exactly where turbines will go and thus what consents are required.

The proposal to secure approval for turbines within 2km at the beginning of the project will prove unworkable. It is impossible for the Joint Regional Planning Panel (**JRPP**) to fairly review the impact of a project in the absence of a complete analysis of the project, which can only occur once all the detailed studies have been undertaken.

A wind farm project continues to evolve from the initial turbine layout in response to constraints identified in studies (environmental, technical, cultural, local amenity) as well as in response to consultation with the community. This would be impossible without access to the Director General's Requirements upon which these studies are based.

<sup>3</sup> *The Social and Economic Impact of Rural Wind Farms*, report of the Senate Community Affairs References Committee, June 2011, p.20

<sup>4</sup> <http://www.austlii.edu.au/cgibin/sinodisp/au/cases/nsw/NSWLEC/2010/1102.html?stem=0&synonyms=0&query=%22property%20value%20>

<sup>5</sup> For example, see the "Explicit Cautionary Notice", viewed at [www.waubrafoundation.com.au](http://www.waubrafoundation.com.au) on 22 February 2012

### **Section 1.3 (b) Community consultation**

See comments below in response to Section 2.2.

### **Section 1.3 (c) Visual amenity**

Vestas rejects the need for a requirement for a Site Compatibility Certificate for turbines within 2km of neighbouring homes, for the reasons set out above in the discussion of Section 1.3 (a).

### **Section 1.3 (d) Noise**

See comments below in response to Appendix B.

### **Section 1.3 (e) Health**

The proposed requirement to reference "up to date evidence-based research" gives little guidance as to how this would be judged by a JRPP or any other decision-maker in the planning process. What qualifies as "evidence-based research" is a frequently debated topic, so this clause provides no certainty to anyone involved in the planning process.

Certainly the anti-wind farm activist groups refuse to accept the peer-reviewed evidence on this topic and have continued to rely on the scaremongering of unregistered doctor Sarah Laurie and information they have harvested from various anti-wind websites.

Given that most wind farm planning stakeholders are not medical experts, we think it would be more appropriate if the Draft Guidelines were amended to require that project proponents consider the project's impact on health, with reference to the latest statements from the National Health and Medical Research Council (**NHMRC**) and NSW Department of Health.

Ideally, the entirety of Section 1.3 (e) should be deleted so as not to give the impression that the NSW Government places any credibility in the false claims of the anti-wind activist groups on the topic of health impacts.

### **Section 1.3 (f) Decommissioning**

The Draft Guidelines state that "wind turbines typically have an expected operating life of around 20-25 years at which point they are usually decommissioned".

There are no wind farms of that age in Australia and so what "typically" happens to



the turbines at this point is unknown. Thus the statement is a ridiculous one to include in a document of this nature, and it looks suspiciously like the kind of statement that is more likely to have been made by the anti-wind activist groups. Vestas does support the inclusion of a Decommissioning and Rehabilitation Plan in the environmental assessment report.

However, we do not support the requirement for proponents to provide a decommissioning bond. It is not clear how DP&I would calculate the level of this bond and until this is defined, we suggest that the requirement is removed from the Draft Guidelines.

Additionally, the requirement for the decommissioning plan to be updated every five years is an unnecessary burden not required of projects in other sectors. Wind farm operators have a clear incentive to maintain their assets for as long as possible because unlike most other power stations the “fuel” for a wind farm (i.e. the wind) is free. Hence this additional requirement is unnecessary.

### **Section 1.3 (g) Auditing and compliance**

We note this section allows neighbours of wind farms to write to the Director General of DP&I to request independent noise monitoring at their house. This section gives no further detail on what grounds this request would be agreed to, such as:

- who would undertake the monitoring,
- who would pay for it; and
- what actions would result if the readings show compliance or noncompliance.

At a bare minimum, such matters should be clarified.

### **Section 1.4 Preparing an Environmental Effects Statement**

No comment.

### **Section 2.1 Consultation requirements (documenting “effective engagement”)**

Vestas agrees that consultation should be “aimed at identifying and considering options for eliminating or reducing impacts”. That seems in line with accepted practice and on the face of it is a good policy.

However, the requirement in 2.1(a) that “the proponent’s assessment report will not be accepted until evidence of effective consultation has been presented and it has been demonstrated that the issues raised during consultations have been appropriately addressed” could cause major issues.

Without further definition of “appropriately addressed”, this requirement could be used by project opponents to delay projects indefinitely. The Draft Guidelines need to clearly state the requirements to be satisfied by the project proponent.

On the specific issue of property values, this is discussed below under Section 3.2.

### **Section 2.2 Who to consult**

Vestas supports wide community consultation with respect to wind farm developments. However, as noted earlier in this submission, we consider the list of required stakeholders should be restricted to **only those who are impacted by the proposed project**.

This means that “organisations that represent those with a state, national or global interest, e.g. peak environment groups and national industry associations” and the “Aerial Agricultural Association of Australia” that currently appear on the list in 2.2 should not require consultation.

Many of them are nothing more than lobby groups, and in any other scenario would

not have standing to interfere in a process like this as they are not local residents. In most cases the views of such organisations are well known and are not directly relevant to local planning issues.

The proponent should only have to consult with people, companies and agencies that are directly impacted by the wind farm in the local area.

Any diversion from this key principle leaves the process open to manipulation by organised protest groups who may not have members who live anywhere near a proposed major project.

Furthermore, given the Government's intention to restore planning powers to local communities, we would recommend that any objections to projects should only be deemed relevant if:

- the objections are from local agencies or members of the public living within a limited distance from the project, perhaps between 0 and 5 kilometres;
- the objections are not merely "form letters" or other verbatim forms of communication; and
- the nature of the objections are restricted to matters relating to the impact of any project on the local environment.

Such restrictions would be likely to focus the planning assessment process so that it addresses local environmental issues and other practical impacts rather than allow anti-development groups from outside the local area to add delay, extra costs and spurious matters and prevent SSD projects from proceeding and making economic contributions to local economies in NSW.

### **Section 2.3 Consultation approaches**

No comment.

### **Section 3.2 Identifying relevant assessment issues (also the subject of Appendix A)**

The list of "issues that typically need to be assessed for a wind farm application" is a long one, and includes many issues that have been raised by anti-wind activist groups in addition to matters that are normally addressed in planning assessments. Vestas wishes to make comment on a number of them.

#### **Health**

As set out in the discussion of Section 1.3 (e) above, Vestas rejects the claims of the anti-wind groups regarding adverse health impacts of wind turbines. We consider that this item should be removed from the Draft Guidelines to properly reflect the most recent peer-reviewed evidence and findings of the NHMRC and the NSW Department of Health on this topic, and to ensure the baseless claims of anti-wind activists are not given any credibility by such a specific reference.

#### **Property values**

Property values are not considered valid grounds in planning matters, yet for some reason have been included as a proposed matter for consideration in the Draft Guidelines. In the Taralga and Gullen Range Land and Environment Court decisions this issue was raised and subsequently dismissed as a relevant consideration in the planning framework<sup>6</sup>.

The quote below makes it clear that the inclusion of such a matter would be contrary to the objectives of the relevant planning legislation:

*160 Creating such a right to compensation (for creating such a right it would*

*be) would not merely strike at the basis of the conventional framework of land use planning but would also be contrary to the relevant objective of the Act, in s 5(a)(ii), for "the promotion and co-ordination of the orderly and economic use and development of land".*

In any event, the 2009 independent study commissioned by the NSW Valuer General revealed that wind farms had no identifiable impact on the value of nearby properties<sup>7</sup>.

That alone means that this particular section of the Draft Guidelines would be yet another example of regulation that is not evidence-based.

<sup>6</sup> See in particular paragraphs 107 to 109 and 159 to 160 at <http://www.austlii.edu.au/cgibin/sinodisp/au/cases/nsw/NSWLEC/2010/1102.html?stem=0&synonyms=0&query=property%20value%20>

<sup>7</sup> *Preliminary Assessment of the Impact of Wind Farms on Surrounding Land Values in Australia*, Duponts, August 2009

#### Blade throw

The occurrence of an incident where a blade from a wind turbine becomes detached from the generator is a rare one, yet perhaps because of its novelty factor has become a common topic raised by anti-wind groups to scare local communities as part of a campaign to stop wind farms being built.

Inclusion of any references to "blade throw" in the Draft Guidelines may please the anti-wind groups but would be in contrast to most other aspects of planning and environmental assessment, which are evidence-based.

DP&I has not provided any evidence to justify such a rare occurrence becoming a necessary issue for consideration in planning assessments. In addition, there are already laws in existence for owners and operators of wind farms to maintain a safe workplace and fulfil their duty of care towards others in the community.

The proposal for planning applications to address such a rare eventuality really widens the scope of matters that proponents need to cover in their applications, and sets a dangerous precedent for all types of planning assessment.

For example, in recent times we have seen reports of anti-wind activists who claim that wind farms could interfere with the migratory patterns of whales<sup>8</sup>. Again, no evidence is provided for such a claim.

At best, the inclusion of "blade throw" as a relevant consideration in the planning assessment framework is another example where the Draft Guidelines discriminate by placing additional regulatory requirements on wind farms when compared with other forms of development and land use.

At worst, the inclusion of this topic as a relevant consideration sets a precedent that would see all kinds of additional spurious topics included in the planning assessment framework for other kinds of development.

Like health and property values, it should be removed from the list of relevant assessment issues.

### **Section 3.3 Conditions of consent and compliance**

No comment.

### **Section 3.4 Community infrastructure contributions**

Vestas supports private arrangements between project proponents and individuals and/or community organisations to deliver community benefits outside of the statutory planning process or assessment framework.

<sup>8</sup> Eden Magnet newspaper, 9 February 2012

Section 3.4 of the Draft Guidelines suggests that "The consent may require the

applicant to provide a contribution, including monetary, land or in-kind contributions, towards community infrastructure". However they also state that "private arrangements with individuals and or community organisations... are outside of the statutory planning process and are therefore not relevant to the assessment". The Draft Guidelines should clearly state whether voluntary payments (whether to a local council or to an individual or community group) are relevant or irrelevant to the planning permit. It should not distinguish between these two types of voluntary payments.

#### **Appendix A: Meeting assessment requirements**

Many of the issues we have with this section have been discussed above, namely the references to health, property values and blade throw. These should all be deleted from Appendix A for the reasons stated elsewhere in this submission. In addition, the statement on typical turbine life discussed in Section 1.3 (f) appears again in Appendix A and should also be deleted.

#### **Appendix B: Noise guidelines**

Vestas does not support the adoption of the noise guidelines set out in Appendix B as they are unnecessary, discriminatory and unclear.

The Draft Guidelines suggest additional, more stringent requirements and assessments with respect to noise compliance. No justification is provided for moving to a new set of regulations that are self-proclaimed as the toughest noise standards in the world.

Despite a lack of evidence that the current standards are inadequate, these additional requirements add to the large body of standards and guidelines already in use in Australia, which are already some of the most stringent in the world.

Rather than introduce new and more stringent noise guidelines, New South Wales should adopt noise limits in line with accepted standards such as NZS6808:2010. This will allow for the separate day time and night time limits, and will allow for the differentiation of residential zones labelled 'rural living' and 'high amenity' (where a stricter limit will apply).

##### **Low frequency noise**

The Draft Guidelines state that "*Analysis of wind turbine spectra shows that low frequency noise is typically not a significant feature of modern wind turbine noise and is generally less than that of other industrial and environmental sources.*"

It is therefore unnecessary to require the prediction and monitoring of low frequency noise emissions from wind turbines. This is especially so, given the absence of regulation or limits upon the low frequency noise from "other industrial and environmental sources" as mentioned in the above statement from the Draft Guidelines. This is a further example of the way in which the Draft Guidelines discriminate against wind farms.

In addition, the existing and well validated industry standard models for acoustic propagation are not designed to deal with frequencies at the low end of the audible spectrum, specifically because noise emissions in this band are not considered to pose issues likely to affect the surrounding environment.

Accordingly, Vestas suggests the removal of the requirement to measure low frequency noise from the Draft Guidelines.

##### **Definitions and additional management of noise characteristics**

In the Draft Guidelines, the definition of a "sustained exceedance" requires that characteristics are present for not more than 30% in any season.

This places an unfair burden on wind farm proponents who would be forced to test for 12 months in order to demonstrate compliance.

A more reasonable test would be when the characteristic was shown to be evident for 30% of the measurement period which must be more than 14 days (typically the duration required to gather sufficient data for assessment against NZS6808:2010). When considering special audible characteristics (tonality for example) a sustained exceedance should be used as the test of non-compliance, using our preferred definition above.

**Appendices C, D, E and F**

No comment.

**Retrospective application to existing wind farm proposals and projects**

The Draft Guidelines do not make it clear which set of rules will apply to existing wind farm proposals that have already begun their path through the planning system, as well as projects that have already been constructed.

The "Questions & Answers" document issued by DP&I in December 2011 states "it is intended that the guidelines will apply" to "existing SSD and transitional applications". Such a proposal has already created significant uncertainty amongst investors and should be rejected completely. The Draft Guidelines should only be applicable to future projects after this current consultation process has been concluded. All other wind energy projects that have already been constructed or commenced their journey through the planning system should be assessed against existing rules rather than the Draft Guidelines.

**Further steps**

Vestas staff would be pleased to meet with DP&I staff to discuss this letter and answer any other questions you may have. Please contact the writer on (03) 8698 7300 to do so.

Yours sincerely,

[signed]

**Ken McAlpine**

**Director, Policy and Government Relations**

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**On the Next page, find:**

**Vestas Letter of Protest to Danish Government regarding Request to Lessen IWT Noise Emissions**

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[Stamp:RECEIVED  
BY THE DEPARTMENT  
30 JUNE 2011]

Date  
Randers, 29 June 2011/erkjs

Dear Karen Ellemann,

Following previous correspondence, I am writing this letter to express my concern regarding the limits for low frequency noise from wind turbines now being proposed.

Back in January 2011 we applauded your announcement of the new regulations regarding low frequency noise and the fact that you also then emphasised that those regulations would not be tightened and that it was a question of improving the security in connection with the installation of wind turbines. Accordingly, the reaction from the industry branch back in January 2011 was positive, although as an industry we were uneasy about having heavier demands imposed on us than other industries.

When the new regulations were then published on 26.05.2011, we were of course convinced of your initial point of view. As a result, we were extremely surprised to find that the proposed new regulations do in fact include a significant and severe tightening of the previous noise regulations.

In fact, according to our analyses, the most economical turbines, the 3 MW category, are the ones that will be strongly affected by the new rules. This applies to open terrain in particular, where in future low frequency noise will dictate and increase the distance requirements to neighbours for close to half of the projects that we are already aware of over the next 2 to 3 years.

In a small country such as Denmark this means that a significant number of projects will not be viable as the increased distance requirements cannot be met whilst maintaining a satisfactory business outcome for the investor.

The Danish market for wind turbines is of minor importance for Vestas in terms of sales, typically less than 1% of our sales per year. However, the Danish market provides a number of other functions for Vestas which are of considerable value from a business point of view. By means of its high wind penetration, 24% in 2010 - still a world record - Denmark has a role as a forerunner country and a full scale laboratory for conversion to renewable energy.

This means that other countries often look to Denmark when adjusting their legislation regarding wind energy. We are therefore concerned - justifiably so as history shows - that the proposed Danish regulations for low frequency noise from wind turbines will spread to a large number of other markets with much higher commercial impact for Vestas and consequently for employment in the business.

The Danish wind turbine industry employs approx. 25,000 people in Denmark and boasts an export which is about 8.5% of total Danish exports. Such "over-proportional" presence has become possible because Denmark

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**Part - 10     Carbon Management**

**We Agree on Some Things**

Climate Change has been proposed as a potential "existential threat" for over a hundred years. With our expanding human population, Man has increasingly sought and extracted sequestered carbon fuels that were then oxidized to gather the energy held between the atoms of hydrocarbons for the purpose of creating energy and heat. As a specie, over our "brief" moment of time on Earth, we have rapidly transformed at least half of our world's landscape into food production and places where we work and live - all facilitated by the creation of carbon dioxide and other heating-retaining molecules. We have grossly overwhelmed the planet's capability to handle our world ecosystems perturbations and now are facing weather extremes that will overwhelm our ability to cope. Having actively left long ago our willingness to remain "integral" to our natural world, we now created a "planet in crisis". At 7.7+ billion current members of this specie, with a projection of reaching 10.5 billion before the year 2100, ALL possible modes of reestablishing more natural and sustainable resource-use patterns over a relatively "short-term" time frame will be essential to minimize further natural systems losses and our viability as a specie.

**Planet of the Humans**

This concept recently was highlighted in the Movie "Planet of the Humans". Not available on Redbox, it can be viewed on YouTube: <https://www.youtube.com/watch?v=Zk11vl-7czE>. There was a greater focus on Biomass as an energy producing option than the financial folly of IWTs. Unfortunately, the movie did not highlight the real concerns of adverse health effects. They viewed recent Renewable Energy focuses as a "profit-driven" venture from the merger of environmentalists and capitalism. The Renewable Energy Tax Credit only incentivizes Wind Energy and their perpetuation of continuing to promote harmful wind farm installations. The movie commented at the end that "it is not CO2 that is destroying the planet, it is us."

**Hard Realities that are Catching Up and Now Need Action**

We need not only better (safer and more efficient) forms of electrical energy production but also to recognize the central tenets of permaculture design as we transform/adapt our current way of living to more planet-healthy partnering. Single focus, high-expense, non-integrated, inherently unhealthy energy-producing infrastructure is NOT what we ultimately need, nor where we should squander our finite (and borrowed) financial resources. In 2018, two Harvard researchers found that meeting current U.S. electricity needs with wind would require "covering" a land area twice the size of California with IWTs. International efforts to bring answers needs to be first approached with (national to local) appraisals of potential impacts of introduced "solutions". People's health (in all its forms) and a safe integration of energy production, food production must be defined, promoted and observed. Actively cultivating and providing healthy human interactions that fosters inner peace, satisfaction in our relationships with others, and inspiration - coupled with empowerment - to embrace joy in our world

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should be our steadfast goal. Lofty thoughts indeed, but it is worthwhile to examine our current course and truly ask where we should be heading.

The forced intrusion of closely sited IWTs into human habitation is immoral and deeply divides our communities. Conquering our "carbon problem" will require multi-level responses and reexamination of current energy usages. Responding to slow/halt/reverse this process will require global commitment enforced with incentives - at international to individual levels. Indeed, future energy security will be dependent on simultaneously reduced as well as more efficient and careful energy expenditure. Perhaps more important will be active implementation of enhanced carbon capturing - particularly in farming practices across the world. Truly, to flourish, let alone survive as a specie and as an integrated planet, will take a sobering embracement of "how nature works" implementing realistic rules of natural energy chains and bonding the human psyche back to its ancestral relationship of being wholly dependent on maintaining "vigorous planetary health". The future will be won by understanding, then accepting a sequence of daily opportunities to "live within our means".

Much smaller-sized IWTs (avoiding infrasound production and carefully sited to avoid health concerns) may have a future in a growing mosaic of blended energy sources. At healthy and environmental-safe sizing and spacing, they could be a part of localized groupings of distributed energy sources, like solar, wind, in-stream hydro together with better future energy storage or backup generation and load management tools. Akin to local food production serving local food needs, the system could operate as a stand-alone entity or its users can plug into the large grid as needed - hopefully on existing power transmission systems - and collectively supply that grid with bi-directional metering. If able to be built and operated economically, and be sited and retain mandated healthy and safe operational status, such microgrids could be ideally positioned in rural areas along with preservation of food production, near larger cities. Additional, but safely buried energy transmission lines could be added only when necessary; it needs to be presented as and TRULY BE a "win: win" situation.

### **Renewable Options Without IWT Risks**

1) Initiate and incentivize farms to work to restore the ORIGINAL richness of our depleted soils through more complex crop rotations, no-till/less soil disruptive planting, use of multi-specie mixtures of cover cropping AND progressive tapering use of chemical control that perturb and threaten entire ecosystem viabilities. (See below)

2) Energy production with PV arrays and roof-top solar water heating. Surge ahead with battery energy-storage development at "acceptable" environmental cost. "True 100% renewable energy" will be ONLY possible with affordable, reliable, and massive-scale battery storage of energy. As long as we depend on "carbon-producing" back-up energy generation (natural gas, coal, petroleum) to supplement "when the wind doesn't blow and the sun doesn't shine", we are not 100% renewable - despite what the commercials on TV state.

3) Micro-grids with shared co-generation back-up and be willing to support research and



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development of nuclear options that are reportedly becoming safer.

4) Implement/Re-direct wind energy production to natural environments not shared with human places of work and living. Yes, I understand the concept of long-distance electrical energy transmission and concomitant inherent energy loss. OFF-shore IWT placement might be reasonable (though expensive) and current estimates of potential wind energy world production could be 22,000 Terawatts of power- far greater than projected future needs. (a Terawatt is equal to 1000 Gigawatts). I caution that we should clearly recognize the tradeoffs of off-shore IWTs on that ecosystem (whale groundings, adverse impacts on key natural coastal areas - fisheries, turtles, etc. MUST be done). Cost implications are horrendous with even greater costs/kw energy produced. Responsible, independent and transparent decisions of environmental impact must be incorporated into controlling levels of government that HAVE the scientific resources to evaluate environment noises of all frequencies. The world's current implementation of massive on-shore IWTs being placed close to people is and will, in retrospect, be considered irresponsible. It is very remarkable that when PBS and NOVA educational shows and television advertisements are seen, nearly all have IWTs operating in areas where homes, cities, and workplaces are NOT seen. It used to be only a couple years ago that MAE would show IWTs on the Iowa landscape associated with farmsteads... that is changing. Again, Wind Energy is working to portray their IWTs as "benign" even though they are not implemented as such.

5) In 2018, the IPCC estimated that we'd need to plant 1 billion hectares (1 hectare equals 2.47 acres) of forest by 2050 to keep the globe from warming 1.5-degree C. They commented that not only was that "undoubtedly achievable" but global tree sequestration is "our most effective climate change solution to date." This is achievable and absolutely vital at many levels. I have planted, with the help of my family, over five thousand native trees and bushes on marginal land near my home over the last 25 years. Such activities foster personal and participating family hope to help the world ahead and beyond generations present. Participation by all Iowans at "county scales"- at least in shared shovels - to reestablish in Iowa natural diversity and vigor - could bring ownership of our personal and trans-generational destiny, and firm-up the shared responsibility of maintaining our global spaceship.

### **An Extraordinary Opportunity for Iowa**

For the last 70 years, the process of "agrochemical farming" has depleted our soils of the organic component that defines soil fertility. Pre-settlement organic content approached 10% which now has declined to 1-2%, reflecting past farming practices and necessitating current dependence on nutrient supplementation and pest control additives. I am not critical of past farming practices, but now with recent recognition of these agronomic consequences and the impacts on global climate health, we must stop and reassess. Regenerative agricultural practices restore "degraded" land - land which we consider to be our best. Farming practices, including no tillage, diverse (and constant) cover crops, on-farm fertility, no or minimal pesticides or synthetic fertilizers and multiple crop rotations, will help to restore on agricultural fields. Upon implementation over 3-5 years of these practices, farmers will start to reverse depleted fertility and reconnect natural nutrient transport systems in the soil horizons and likely provide greater net profit returns due to the reduced costs of fewer inputs. The practice creates more resilient soil structure that allows greater rain retention at a time of increasingly bigger single-

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event rains and will provide greater drought protection - both needed as climate change brings wider weather swings. It will reverse current farming practices from carbon positive to carbon negative through reconnecting soil mycorrhizal fungi to crop roots returning (sequestering) carbon to the soil and reducing our direct and indirect dependence on carbon fuels currently used to produce crops. There are much better options we have to individually fight climate change than allowing IWTs to dominate our land use.

Very rapid, incentivized, widespread adoption of restorative agriculture would give us a few more years to develop other, less harmful energy production. Wind energy will NEVER be able to stand-alone for our electrical needs. That model will always require increasing large-scale utilization of natural gas (currently being dramatically expanded in usage) that significantly negates the value of "renewables". It may be that only nuclear energy (in a much safer and secure form) along with maximized solar energy production can save our world. All of this MUST be coupled to dramatically reduced (through improved efficiencies) energy consumption and carbon sequestration along with world-wide adoption of carbon crediting. In the end we will have to face the reality of "living within our means".

I agree with the concept and the threat of Climate Change. (That is the major reason I care so much about understanding the place of turbines in our county and our world). I originally liked the concept of "clean energy", but once learning of the realities of the noise that IWTs make and the human harm they cause (directly or indirectly), I have had to reposition the value of IWTs in the solutions we need to power our planet. After careful study and deep hunting for the "disconnects" of Wind Energy's behavior and position on AHEs, it is my opinion that they must say the "half-truths" that they do because to now acknowledge the much more rational stance against wind turbine noise and AHEs would mean the end of their expansion into populated areas and could possibly topple "the empire" they have created so far.

A Revealing Insight of what has happening in Germany as they struggle to "go Green". Please copy then paste to your address bar to read this May 2019 review.

[https://www.forbes.com/sites/michaelshellenberger/2019/05/06/the-reason-renewables-cant-power-modern-civilization-is-because-they-were-never-meant-to/amp/?\\_\\_twitter\\_impression=true](https://www.forbes.com/sites/michaelshellenberger/2019/05/06/the-reason-renewables-cant-power-modern-civilization-is-because-they-were-never-meant-to/amp/?__twitter_impression=true)

#### Appendix:

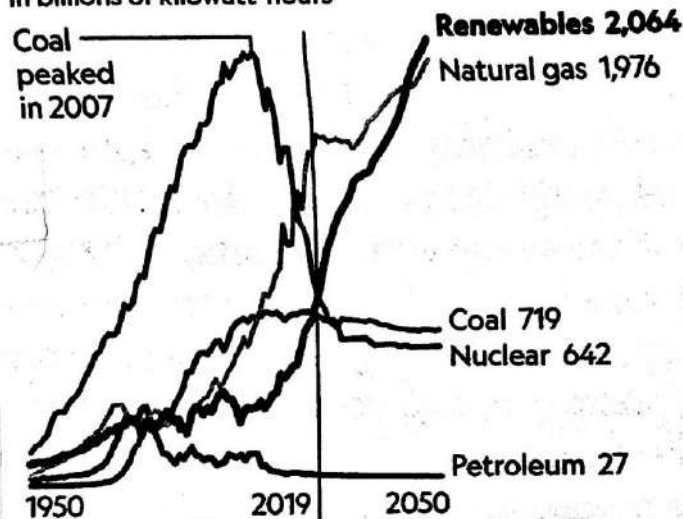
National Geographic Projection of Electrical Generation by 2050. Note Winners and losers of various energy product means. Of note is the steady rise of "renewables" shadowed by expensive back-up generation of power through natural gas carbon-producing sources. Nuclear and coal have plateaued. Likely net-zero Carbon state has been reached by 2050.

Taken from **National Geographic**, April 2020

Graphs from Earth Day 50th Anniversary Special Issue

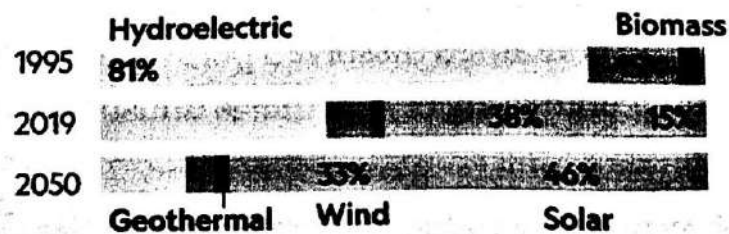
An Optimist's Guide to Life on Earth in 2070

**U.S. ELECTRICITY GENERATION  
BY MAJOR ENERGY SOURCE, 1950-2050**  
in billions of kilowatt-hours



Wind energy currently makes up a larger part of renewables than solar, but not for long. Solar is projected to triple its share by 2050 to become the leading renewable.

**SHARE OF RENEWABLE ENERGY, BY SOURCE**



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**Part – 11: Applied Regulation of Noise**

**Relevance of Background Noise:**

Rural night-time background noise is conservatively 25-30 dBA in the Arbor Hills area - and certainly WAS that in the Macksburg area. Noise levels from an unwanted source becomes more noticeable and objectional as it becomes louder than background noise. The International Standards Organization, ISO/TC 43, United Nations, 1969, noted that a community's response of a 10 dB rise above background produces "widespread complaints". A 15 dB increase produces "threats of community action". Additionally, IWT noise is somewhat unique in that it is frequently recognized at levels 10 dB BELOW background levels.

The American National Standard Institute (ANSI) Criteria for Compatibility lists 30 dBA Lmax for night noise and 40 dBA day with a Leq of 34 dBA. This same organization has stated that wind turbine noise is compatible in rural areas when below 30 dBA, marginally compatible between 30 and 35 dBA and incompatible above 35 dBA.

The 2009 W.H.O published guidelines for OUTDOOR noise levels in residential areas based on comprehensive peer review of medical evidence of health effects from noise. They issued average yearly outdoor NIGHT-TIME noise levels:

- 1) Up to 30 dBA level - no substantial biological effects
- 2) 32-42 dBA levels - Effects on sleep are noted - body movements, awakening, arousals, Children, shift workers, pregnant women, the chronically ill and elderly are all more susceptible. Effects are considered modest.
- 3) 42-55 dBA levels - Adverse health effects are observed. Many people have to adapt their lives to cope with the noise at night. Above 40dBA Lmax is incompatible due to sleep impacts with 12% of residents being very annoyed.

In 1974 the US EPA published a methodology that can predict the community reaction to a new noise. It was developed from 55 communities noise case studies. The baseline noise **levels** include adjustments for the existing ambient, prior noise experience and sound character. Noted at:

32 dBA - No reaction and sporadic complaints

37 dBA - Widespread complaints

45 dBA - Strong appeals to stop noise

54 dBA - Vigorous community action

The published results of the Health Canada study in 2015 reported the percent of people who were very or extremely annoyed (together considered as "highly") to wind turbines as a function of wind turbine noise.

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10% in the 35-40 dBA range

13.7% at the 40-46 dBA range

In Germany, the state-mandated IWT sound-limit is 35 dBA Leq. This is equal to levels of 41-46 Lmax outside which means 35-40 dBA levels inside with window partially open or 39-44 dBA fully open. Resident noise - triggered awakening to full consciousness is seen with the noise levels of 42 dBA or higher. No disturbance at 30 dBA or lower (no wind). Sleep architecture disruption starts at 32 dBA. Even with those lower levels, the German people are still very unhappy living close to these turbines and complain about the noise.

#### **Lmax vs Leq - Relating to an Open or Closed Window**

The L (max) indoors can be related to regulatory requirements outdoors via recent testing in Vermont showing the outside-to-inside noise reduction (OINR is -6 for window partially open). So if you want to prevent impacts such as motility (32dBL(max) indoors) then the intrusive noise outdoors (Lmax) should not exceed 32+6 or 38 dBA Lmax.

Waking up at night Lmax = 42 dBA indoors. Add 6dB for windows partially open, to get a limit of 48 dBA Lmax outdoors.

Wind industry wishes to predict average (Leq), not maximal (Lmax), noise levels. However recent testimony from wind industry consultants (Epsilon, RSG) set the ratio of average Leq to maximum Lmax at +6 to +11 dB. Regulating sound levels to "thresholds characterization" of biological systems is optimally achieved through Lmax ("shall not exceed") language.

#### **dBA calculations for 108 dBA mean power level (2 MW Vestas 110 IWT)**

<b>Feet from tower:</b>	200	500	1000	1500	2000	2625	3000
<b>dBA (Leq):</b>	61	53	47	45	41	40	38

#### **Calculation Basis:**

**It is also not widely known that IWT clumping (siting) and other factors can dramatically increase sound levels at the receptor (property line or home).**

ISO 9613-2: Results have a +/- 3 dB variability about the calculated mean out to 3300 feet

Atmospheric and ground attenuation factors ignored, conservative for low frequency noise.

For two turbines with same distance, add 3 dBA to results

For three turbines with same distance, add 5 dBA to results

For five turbines with same distance, add 7 dBA to results

Sound levels changes at 6 dB per doubling of distance out to 3000 feet

The closest turbine or turbines control the sound level at a location

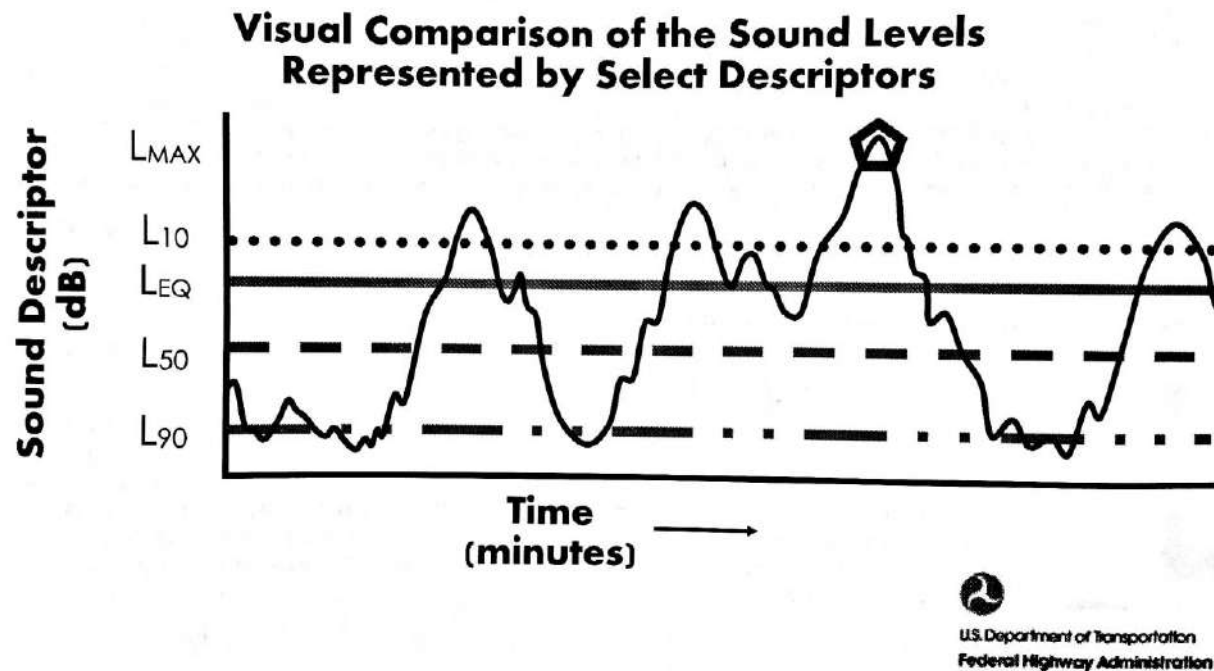
Decibels should be quoted to the nearest whole number (round up or down)

**Implication of Leq:**

L max is up to 11 dBA higher (between 6-11 dBA) than the Leq calculated. Leq should be considered as an average which Lmax as "shall not exceed". A 40 dBA Leq can produce a 51 dBA Lmax at that location (Epsilon/RSG, Tuscola Wind III Almer Township, 2017 - testimony from wind industry consultants)

**Definition of Lmax(fast)**

This is the A-weighted, fast time-constant, maximum, sound level – Note maximum is not “peak” This characterization should be preceded with the “not-to-exceed” phrase as to clarify to project developer. It should not be misconstrued as some type of average.



#### Outside-to-Inside Noise Reduction:

Confirmed by two independent firms in Vermont, 2014

- 1) -6d dBA reduction with windows partially open

e.g. Windows partially open: 42 dBA Leq +11 (convert to maximal Lmax)  
and -6 (attenuate for window) = 47 dBA Lmax indoors

- 2) -1 to -3 dBA reduction with windows fully open

e.g. Windows closed: 42 dBA Leq + 6 dBA (convert to conservative Lmax)  
and - 2 dBA for windows fully open = 48 -2 = 46 dBA Lmax indoors

#### Windows Open or Closed?

I have not yet heard from any Wind Energy (or Mr. Clifton) as to why a non-participating resident who is suffering annoyance from a IWT placed 1500 feet away from his home in an effort to mitigate the

intrusive IWT nighttime noise should have to resort to closing his windows at night in order to lower the audible IWT noise level from a "loud" 45 dBA Leq (56 dBA Lmax) outside to roughly 41 dBA Lmax inside (which represent a 15 dBA reduction (56-15 = 41) which is possible with a well-insulated house but is still remains 9 dBA above the goal of 32 dBA Lmax). We have to consider that people have a right to sleep with their windows wide open and the heads of their beds near the windows. This was a common arrangement before whole house air-conditioning made sleep at night during the warm weather easier. Very low frequency sound attenuates very little from outside to inside even with "windows partially open". Depending on natural resonance in the home's rooms the drop in dBs can be 0 to 7 for frequencies of 20-100 Hz. For frequencies below 20 Hz that range becomes smaller, and when the room resonant frequency is similar to the frequency of the outside sounds it can create a higher sound level inside than outside.

The above is one issue that is very influenced by each family's lifestyle and the type and age of their home. To further complicate things, modern homes are built and use HVAC systems that result in very low sound levels inside the homes when people are sleeping. Levels of 18 dBA or lower are common. That means with the introduction of the newest generation of "quieter" air conditioning systems that the IWT-produced low frequency rumble is no longer "masked" as had been experienced by previous generations of "louder" air conditioning systems at night when people are at rest. Sometimes now, people suffering annoyance during attempted sleep due to significant interior home IWTs noise levels, often have had to purchase "noisy" box fans and run them at night to provide adequate masking noise. Others have bought Bluetooth speakers and use their smartphones to play white noise or other masking sounds. The point being that modern homes can be too quiet (well sound insulated) if one lives in a noisy neighborhood. And, for a rural population not accustomed to nighttime noise, the new intrusions will be very unwelcome and a source of disturbance. That is why ANSI S12.9, Part 4, Appendix F includes a statement that installing a new noise source in a previously quiet community requires a penalty of 10dBA on that rural noise source to equal the annoyance for a similar noise in a suburban community.

Any way you look at it, IWT will likely disturb your sleep when sited too close to your home. Sleep disturbance is a serious adverse health effect. The only solution is substantial distance separation (2-3 km, 1.25 -2 miles) or (as has been court-ordered after wind farm construction) complete inactivation of IWTs during the night (10 PM to 7AM). At distances of <1.25 miles in flat ground without "grouping" or "in-line" turbine placement, you will have complaints. **Complaints mean that the county has failed to protect their residents.**

### **2007 WHO Nighttime Noise Guidelines**

The 2007 World Health Organization revised its guidelines for nighttime noise. Those guidelines provide the definition of what is required for a causal link to be established between an exterior forcing agent like noise and health. They state:

"Sufficient Evidence": A causal relation has been established between exposure to night noise and a health effect. In studies where coincidence, bias and distortion could be excluded, the relation could be



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observed. The biological plausibility of the noise leading to the health effect is also well established.

"Limited Evidence": A relation between the noise and the health effect has not been observed directly, but there is available evidence of good quality supporting the causal association. Indirect evidence is often abundant, linking noise exposure to an intermediate effect of physiological changes which lead to the adverse health effects.

In Table 3 of the 2007 Guidelines, the WHO presents the maximum sound levels that should be permitted **outside the walls** of a home to prevent health effects. The new criteria are based on recent research into nighttime noise and health that was not available in the 1999 guidelines. The outdoor criteria (Lnight-outside) represent long-term conditions, not a single night's exposure. I will type Table 3 as it originally appeared:

**Table 3. Summary of the relationship between night noise and health effects in the population**

Lnight-outside: up to 30 dB	Although individual sensitivities and circumstances differ, appears that up to this level no substantial biological effects are observed
Lnight-outside: 30 to 40 dB	A number of effects are observed to increase: body movements, awakening, self-reported sleep disturbance, arousals. With the intensity of the effect depending on the nature of the source and on the number of events, even in the worst cases the effects seem modest. It cannot be ruled out that vulnerable groups (for example children, the chronically ill and the elderly) are affected to some degree
Lnight-outside: 40-55 dB	There is a sharp increase in adverse health effects and many of the exposed population are now affected and have to adapt their lives to cope with the noise. Vulnerable groups are now severely affected
Lnight-outside: Above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a high percentage of the population is highly annoyed and there is some limited evidence that the cardiovascular system is coming under stress

The 2007 version was the preliminary document from the working group and is expressed as WHO researchers intended. When released there was a lot of political pressure put on the WHO to adhere to EU Directive policies. The 2009 version was released to parallel to the EU requirements for annualized

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limits and other changes that were not appropriate for health effects due to short duration, low level events.

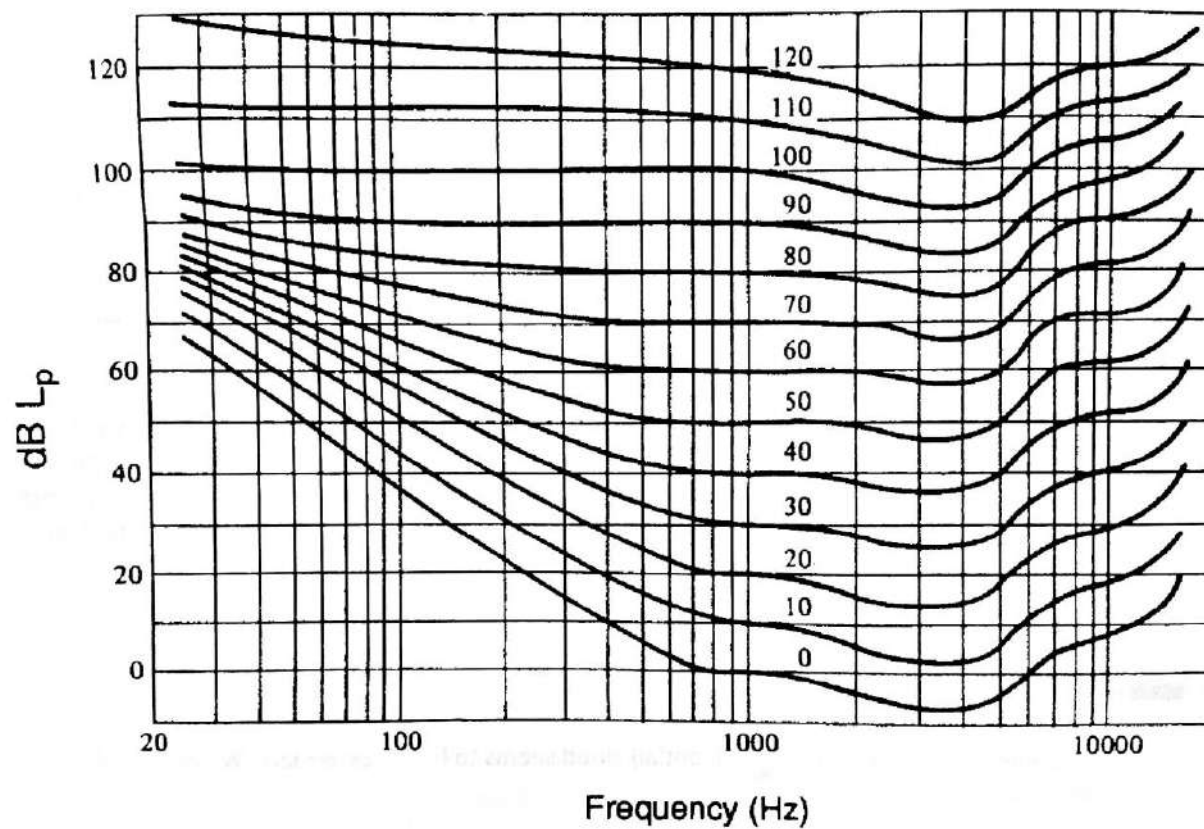
## **Loudness –Variations Over the Sound Spectrum**

Equating decibel differences (more or less than reference) to a change in loudness varies over the range of the sound spectrum. The “Phon” loudness chart below (40 phon = 40 dB Lp at 1000 Hz) shows how low frequency noise “loudness” at smaller decibel changes.

This shows that lesser changes in sound intensity (dBs) can increase “perceived” loudness at lower frequencies. At 1000 Hz, going from 40 to 50 dB (up by 10 dB) increases the “loudness” by a factor of 2, i.e. twice as loud. While at the lower frequency of 100 Hz, increasing the sound intensity from 41 to 46 (up by 5dB) also increases the loudness by a factor of 2, i.e. twice as loud.

Significant importance of this “steeper” loudness change with lesser dB change within the low-frequency noise range is potentially considerable. This noise property may create more annoyance/noise recognition from this already problematic zone in terms of creating sleep disturbance. Having said that, loudness considerations may be best used in only simple situations. Complex sounds that have tones, fluctuations in the frequencies, where energy is concentrated and other aspects of psycho-acoustics like “sharpness” all make it much more complicated.

The underlying sound physics in judging “loudness” are, as noted, complex. Yet despite that acknowledgement, larger IWTs with greater energy producing capacity are expected to increase both audible and ILFN emissions. Such heightened noise production in the ILFN range may be recognized with disproportionately greater loudness with potentially a greater percentage of residents become capable of “hearing” those lower-frequency emissions.



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## Part - 12 Ordinance Examples and Regulation

(This is huge topic; I have included SOME of the more important concepts)

### **Setbacks - Considerations and Recommendations Designed to Minimize Adverse Health Effects**

Setbacks should be measured from a non-participant's property line. Wind Energy's template ordinance suggests (essentially assumes) that the receptor locale will be the house. By defining that "house" as the measuring locale, it becomes the closest structure (of importance) to the closest platted IWT. A setback measured from a dwelling limit the non-participating landowner's use of their property, and greatly reduces protections for non-participants from noise pollution and its proven ill effects, shadow flicker, property devaluation and potential property damage from blade failure or fire.

All landowners should have the right to do with their land what they choose as long as it doesn't harm or impede a neighboring land owner. A setback for safety reasons, regardless of its distance, must be maintained. Any ordinance that allows a wind turbine to be built closely next to a non-participant's property line eliminates that property owner from safely using that land. It creates a virtual access easement over the neighboring, non-participating property that eliminates the owner from any further developments. This amounts to an uncompensated taking of private property rights.

In Robert Bryce's book "A Question of Power", on page 198, he mentioned in Henry County, Indiana, where seven communities passed resolutions establishing a four-mile buffer zone around their towns. He also related the thoughts of Kevon Martis who has consulted with dozens of rural governments in the Midwest to help them craft and implement land-use regulations that will protect them from the encroachment of Big Wind. Martis believes the fundamental problem is that, by installing huge turbines, the wind industry is getting "uncompensated nuisance and safety easements" on the unleased property that sits nearby. The result is what he calls "trespass zoning". By establishing setback and noise limits from homes rather than property lines, Martis says that the wind industry is getting a de facto subsidy from neighbors without compensating them. That he argues, "is fundamentally unjust and flies in the face of sound zoning principles". Martis asserts that the only way for the wind industry to continue expanding is for it to acknowledge the costs it is imposing on nearby landowners and to buy easements from them. Of particular clarity, acousticians remark that enforcement of pollution (including sound pollution) begins at the property line.

### **Siting turbines should include consideration of:**

IWT audible noise levels and all potentially harmful IWT emissions (including ILFN) that could impact adjacent, non-participating properties

Safety zone requirements made by the manufacturer

Wake turbulence

Consideration of proximity of other turbines (even not in the same county or owned/operated by same power company requesting permitting) – will increase lower frequency noise levels through amplitude modulation. In general, regulation by NOISE/IWT emissions should be through measured values. Wind Energy templates often do not specifically measure those noise levels but will state only a distance (e.g. 1500 feet). If accepted, it is not uncommon that IWT clumping or arrangements in a linear row, “can be done” that may markedly increase noise levels at the receptor while remaining in compliance for distance.

Future growth of towns and cities and likely concomitant new hospitals and schools. County Board of Zoning and local communities should coordinate together to anticipate possible 58 years of community potential growth being unthreatened by future unhealthy Wind Energy noise emissions.

### **Setback Proposals**

Because of widespread concerns about health and safety, many jurisdictions scattered around the United States and Canada have adopted larger setbacks.

Noise level regulation typically includes dBA sound rating with more comprehensive noise protection includes some measure noise level that more accurately quantitates the ILFN emissions. The Punch and James review listed several distance setbacks that varies but the average distance was 1.25 miles or 2 km. This distance was chosen to protect against harmful low frequency emissions. That distance was most often derived from evaluations of setbacks that did not produce noise or symptoms complaints attributed to noise emissions. Increasingly – particularly with recent Wind Contractor’s practice of re-tooling IWT with larger blades/nacelle generators – that can substantially increase ILFN noise emissions that lead to increased complaints. It might be advisable to limit re-tooling options and limit increases in turbine heights. The impact of multiple adjacent IWT re-tooling to, e.g. 0.5 MW or greater, could markedly increase receptor noise levels changing a marginally tolerable environment to one which requires night-time evacuation to achieve restorative sleep.

Permitted sound levels across most Australian States for all industrial equipment are background noise levels plus 5dBA or 35dBA whichever is less, whereas for wind turbines they are background plus 5dBA or 40dBA whichever is more. There is no scientific evidence or reason for this difference. An increase of 5 dBA represents an approximate doubling of the sound level. Most rural environments have a background noise level of 18dBA to 25 dBA, approximately averaging 22 dBA at night. This represents a huge increase in audible sound. Increases of 10dBA at night are long known by acoustic consultants to raise complaints, and increases of 15-20 dB are associated with widespread complaints and legal action. Averaging measured levels of sound across too-wide of frequency bands also allows the hiding of sound pressure peaks to which the ear responds, understating the true extent of facility noise emission levels.

The WHO (World Health Organization) Night Noise Guidelines for Europe quote the 1999 Community Noise Guidelines: **"If negative effects on sleep are to be avoided, the equivalent sound pressure level should not exceed 30dBA indoors for continuous noise"** Cities have a higher background noise than

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country areas. Denmark limits indoor noise from industrial sources, including wind turbines, to a maximum of 20 dBA at night.

The currently permitted outdoor noise level in New Zealand and some Australian states has been ameliorated somewhat by the addition of a deduction of 5dBA from the 40 dBA limit to allow for especially quiet environments.

History has shown that these Australian guidelines were based on ETSU97 from the UK, and were expressly designed to encourage development of the wind industry, not to protect the health of rural residents from wind turbine noise. Predictably, because the Kelley criteria limiting exposure to impulsive ILFN were ignored, these guidelines have turned out to be completely unsafe. (noted Hanning, et. al. review of ETSU-R-97 guidelines and significant deficiencies to protect health).

It is therefore necessary to predict and measure sound pressure levels across the full spectrum of frequencies in order to predict and control sound energy impacts on project neighbors.

The L (max) indoors, can be related to regulatory requirements outdoors, via recent testing done in Vermont showing the outside-to-inside noise reduction (OINR is -6 for window partially open). If you want to prevent impacts such as motility - (a marker for sleep arousal associated with potential sleep disturbance) (32dBL(max) indoors) then the intrusive noise outdoors (Lmax) should not exceed 32+6 or 38 dBA Lmax.

Waking up at night Lmax = 42 dBA indoors. Add 6dB, to get a limit of 48 dBA Lmax outdoors. Both motility and awakenings reflect disturbed sleep - **BOTH EFFECTS SHOULD BE AVOIDED through ordinance language to reduce in-bedroom levels.**

Wind industry predicts average, not Lmax, noise levels. However recent testimony from wind industry consultants (Epsilon, RSG) set the range of average Leq to maximum Lmax at +6 to +11 dB

So, to determine conservatively the **average** wind industry predicted-level limit, subtract 11dB from 48 and get 37 dB Leq. Anything above that is associated to "waking up in the night" with the windows partially open.

#### **Additional Published Sound Limits:**

Health Canada determined highly annoyed residents ramped up quickly above 35 dBA outdoors

ANSI (American National Standards Institute) standards for Compatibility with Land use determine in rural residential land use, unfamiliar intrusive noise is incompatible at night above 35 dBA, marginally compatible between 30 and 35 dBA and compatible below 30 dBA.

Hayes-McKenzie Partnership recommendations made in 2006 limited maximum wind turbine sound levels at residences to 38 dBA and no more than 33dBA if "beating noises" are audible.

Michael Nissenbaum. M.D. issued his findings in 2010 from his medical study at Mars Hill,

recommending a 7000-foot setback for public health.

Stephen Ambrose and Robert Rand, professional acoustical consultants with decades of experiences with IWT sound emissions, advise the noise level not exceed 32 dBA at the property line of any abutting wind turbine facility to ensure minimal LFN and infrasound content; the 32 dBA measurement would also be a proxy for LFN and infrasound. Wind turbine facility designers and their acoustical consultants would need to have a design target of 30 dBA to ensure 32dBA is realized. Further, if utility-scale (1.5MW to 3 MW) wind turbines are sited at least 1 mile from the property line of any abutting property, it is likely any audible noise will be attenuated below 32 dBA. To avoid devaluing any abutter's property, etc., the abutter property line is used.

Rick James and George Kamperman, professional acoustical consultants, have extensively studied wind turbine noise. They recommend a noise LIMIT at the property line for: 1) audible noise: 35 dBA or no more than 5 dBA above the pre-construction ambient dBA level, whichever is **lower**. 2) LFN 50 dBC or no more than 20 dBC above the pre-construction ambient dBC level, whichever is lower. We need to start quantifying infrasound and LFN permissible levels which will require that Wind Turbine producers need to provide emissions data to reflect "worst possible scenario".

Rural Oregon has set minimum setback at 2 miles.

Victoria and New South Wales, NZ have set the minimum setback at 2 km (1.25 miles) - this despite Vestas getting the approval to "eliminate consideration of infrasound".

In a settlement reached in a wind turbine dispute in Fayette County, Pennsylvania, the setback was set at 6000 feet (1.1 miles)

An investigation into wind farms and noise by the UK Noise association finds an appropriate setback to be 1 to 1.5 miles. (7,900 feet)

Recommendations on the siting of wind farms in the Vicinity of Eskdalemuir, Scotland (2005) found an appropriate setback to be 10 km (6.2 miles or 32,730 feet)

Professor Moller, an internationally known acoustical scientist commented that "at low frequencies, the perceived intensity, the loudness, increases more steeply above threshold than at higher frequencies. A few people would probably accept 25 dBA **in their home at night**, but hardly anyone would accept 30 dBA".

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## Part - 13 Recommendations

### Recommendations:

**Sound levels Limits should be described as (Lmax) and not (Leq).** This sound level characterization is more important when considering sleep/school sound environments. It is also a more consistent sound target thus being more than enforceable than Leq. Observed IWT siting patterns by MAE suggest a preference for clustering thus making accurate predictions of target sound level more difficult. Consideration for IWT siting reflecting the possibility +11 dBA audible sound level amplification likelihood during strong, unsteady winds should be observed. Worst case scenarios should be incorporated into setback calculations NOT just from the manufacturer's listed power sound level (e.g. for V-110 2 MW is 108 dBA) but from that value and perhaps an added 10 dBA to avoid any transient sound levels of >3-5 dBA in "worst case scenarios".

Stated noise limits as "shall-not-exceed"-\_\_dBA Lmax (fast) (fill in the upper range of noise as measured in dBA that you wish. 35,40,45 dBA – the lower, the quieter the noise becomes – particularly at night which is the most important time as that is when the turbines produce the most energy and the wind are more consistently higher aloft. In addition, using a C-weighted Lmax dBC level to regulate ILFN is also advisable with the increasingly common desire to increase energy production density within a wind farm. Values of 50,55,60 have been used. I would point the reader to George Hessler's 2004 article (Noise Control Engineering Journal, 52 (4), 2004 Jul-Aug). The initial summary begins with the recognition that excessive low-frequency noise from (industrial sources) as a serious noise and vibration problem since the early 1970. At the time of this article there was no standardized noise criteria in the U.S. to consult for guide. His paper proposed a C-weighted level criterion. In table 1 – labelled as maximal allowable C-weighted sound level (dBC Lmax) at residential areas to minimize infrasound noise and vibration problems. For very quiet suburban or rural residential areas, with extensive or 24/7 source operation, levels of 60dBC were suggested.

Siting should be connected to a single proposed IWT power design. Re-tooling at a later date with a more powerful IWT **WILL produce** a different spectrum of sound emissions. With larger MW turbines, a much greater percentage of produced sound frequencies will be in the infrasound and low-frequency ranges and sound levels will be higher at every frequency in the ILFN sound spectrum. The frequency ranges can be more harmful in sensitized individuals producing greater sleep disturbance. Indeed, sound profiles may shift such that audible sound produced in the low-frequency spectrum may become louder than those present in the more usual audible frequencies (>200 HZ) - this may be true EVEN if dBA limits are in compliance. Using A-weighted filters to measure IWTs with <1.5-2.0 MW power levels is marginally useful. Above 2 MW, assessing sound levels (loudness) with dBA measures will likely miss a majority of harmful frequencies and grossly underestimate their impact on health. The not-infrequent complaints of thumping are more noticeable with more powerful IWT designs. Medical researchers are starting to focus on the startle response to acoustic and vibration input. Wind turbines produce, BY DESIGN, acoustic pressure pulsations (barometric pressure changes) at blade pass rates.



The pulsations are impulsive, not sinusoidal. Larger turbines with their longer blades can create greater vertical disparities of loading along the blade... these are described in terms of blade loading, deformation, eigenfrequencies (resonance) and dynamic stall. Indeed, what you can't hear or choose not to measure in sound pressure levels, **can** hurt you.

The transmission attenuation of longer wavelength infrasound emissions is roughly only half that of longer wavelength audible sound. This leads to IWT sound perception at far greater distances by susceptible individuals. For IWT with power levels >2 MW, the manufacturer's data reflecting sound pressure levels through the entire infrasound and low frequency noise range **MUST** be made available prior to permitting. The ANSI (American National Standards Institute - a private, non-profit organization that oversees the development of voluntary consensus standards, limits noise levels in the 16 Hz band (in infrasonic zone) to 65 dB. This **NEEDS** to be clearly stated in the Wind Ordinance. There are other published sound measures that are useful to assess sound pressures in the infrasound bands and are even more restrictive. It is likely that Wind Contractors will be willing to adhere to this, as single-band noise intensity measurement equipment is not commonly available.

It should be written in the ordinance that any facility requiring a special permit "shall comply" with all relevant ANSI standards and "shall be compatible" with the existing land use.

The ordinance could require a prohibition for any facility (source agnostic) on recurring acoustic pressure pulsations with peak levels exceeding 60dB re 20uPA below 1 Hz at any point on residential property lines. Ref: ISO 9996 prohibiting "perceived or actual" oscillations in the range of 0.1 to 1 Hz (pertains particularly to avoiding dangerous health consequences of low frequency emissions - particularly a threat with larger MW IWTs)

The 2018 European Commission (EC) in 2002 defined Lden (day-evening-night) as consisting of three parts - the day, the evening and the night average sound levels **outdoors (not inside homes)**.

Reviewing all 12 cited recommendations in the Punch and James article with the noise outputs of Mid-American Energy's planned use of 2 MW Vestas Model 110 IWTs the enormity "disconnect" of the Clifton/Price draft of 1500 foot setback becomes readily apparent. In terms of distance, the closest "minimum distance" recommendation was 0.87 miles (1.4 km) among the first six references. The seventh reference (Cummings, 2011) listed a distance of 0.5 miles or greater with noise levels within 5-10 dB of existing background. Rural noise levels are described at L(90) of 25-30 dBA in multiple references. To keep a projected IWT sound level <40 dBA Lmax (not to exceed 40 dBA) using published data of Leq (average) sound levels, you need to subtract 6-11 dBA from Leq (average) to arrive at the Lmax level (conversion obtained from sworn testimony given by Wind Energy). This conversion reflects that constant oscillatory nature of the IWT-emitted sound that is expressed as a mean value. A Leq value of 40 dBA varies maximally by 11 dBA from the mean (ranging from 29 to 51 dBA) to minimally by 6 dBA (ranging from 34 to 46 dBA). Using the 108dBA mean power level - that is specific to the 2 MW Vestas 110 IWT - mean sound levels as a function of the setback distance can be calculated:

### **dBA calculations for 108 dBA mean power level (2 MW Vestas 110 IWT)**

**Cardiologist's Investigation and Response  
to Industrial Wind Turbines in the Rural Residential Countryside**

**Nov. 28, 2020**

<b>Feet from tower:</b>	200	500	1000	1500	2000	2625	3000	4000*	6000*
<b>dBA (Leq):</b>	61	53	47	45	41	40	38	34*	31*

\* (conservatively estimated at 4000 and 6000 feet)

In general, sound attenuated (lessening, due to travel through air) is -6 dBA for a doubling of distance. This attenuation is reasonably reliable in steady winds up to 3000 feet but becomes less predictable - likely less -beyond 3000 feet. If you assume a dBA variation of 8 dBA inherent with the listed Leq ratings (approximately midway in the 6-11 range), you would need a Leq of 30 to achieve peak Lmax values of 38 dBA. Conservatively acknowledging the problem of calculating audible sound levels at distances greater than 3000 feet, to achieve a sound level of 40 dBA requested by the Cummings article cited by Punch and James, you would need to be at least one mile from the residence. Cummings even suggested 30-35 dBA as levels of 40 dBA or higher trigger large numbers of noise complaints. Finishing the last 5 references that specified sound levels (Lmax), all were <40 dBA with levels of 30,32 and 35 dBA also being listed.

Summarizing, the Clifton/Price setback distance (Wind Energy template) of 1500 feet is nearly 2100 feet closer than the next closest suggested, published setback in the Punch/James article. Noting: 1) various turbines manufacturers have different mean power levels and they may vary as technology changes in the future and 2) separation of noise source to impacted humans is THE primary consideration of separating IWTs with their inherent adverse health effects which increase with shorter distances, I

**would Strongly recommend that IWT and residence/non-participating property lines separation be determined by calculated sound levels measured as Lmax.**

Lmax (or expressed as "shall not exceed") is much more definitive as a quantified exposure and understandable and correlatable in reflecting health-related noise exposure. In addition, it is much easier to monitor for industry noise emissions compliance. It is sobering to think that a 50 dBA Leq (average) maximal noise limit (proposed by Clifton/Price) makes it allowable to have perceptible and measurable sound levels of up to 61 dBA. The very restrictive Dallas County, Iowa limit of 30 dBA Lmax vs the Clifton/Price proposed level of 50dBA Leq with an industry-acknowledge implied peak level as high as 61 dBA Lmax represents 1000 times increase in sound intensity which correlates with 8 times increase in sound loudness. Hard to imagine trying to "force your mind" to sleep with noise levels that high.... Is it reasonable to force residents to actively seek measures (ear plugs or basements/highly sound-insulated structures or sleeping medications or be forced to flee their home) in order to achieve a reasonable night's sleep on their own property that was purchased before a Wind Energy developer sought to achieve substantial monetary gain by placing a 500 foot high IWT only 1500 feet from their home?

**Important Included Components of Wind Ordinance (Textbook's and other sources Recommendation)**

From the textbook "Wind Farm Noise", (2017), Section #1.6 reported on "regulations". The section is divided in several areas. Some are included here and I have added others.

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1) Minimum Setback distance to Residences

The setback distance is the distance from the nearest turbine in a wind farm to a residence, provided that the resident is not a turbine host. They did not specify a suggested setback for a 2 MW IWT although did mention Shepherd, et al, recommendation of 2 km in hilly terrain. This is in keeping with the recommendation of 1.5 miles to the property line as set by the Madison County Board of Health. That value reflects the average setback as described in the Punch and James comprehensive article that thoroughly reviews this information. For larger IWTs of 3MW, the Wind Farm Noise authors suggested a distance that is "much larger" to provide acceptable levels at night when people are trying to sleep.

2) Maximum Allowed Calculated External Noise level

This is the where one's convictions to protect resident's health is challenged the most. The MAE pattern of IWT citing in Adair County is based off the 1500-foot setback. That will guarantee very serious resident protests, a high level of annoyance, wide spread, multi-level adverse health effects and home evacuations. It is a failed siting arrangement and litigation will certainly emerge. It is unfortunate that MAE can offer only huge industrial - sized turbines. That option was not commented on by Mr. Clifton. **Forcing "close-siting" at <1.25 miles with night-time sound levels of >40 dBA Lmax is NOT SAFELY POSSIBLE!!! I have spent a great deal of my time over the last 2 years to be absolutely comfortable with that assertion. At that suggested distance and nighttime sound level, there is already a compromise.**

Maximum allowed calculated external noise levels approximately 100 feet (30 meters) from the exterior of a residential structure. The ISO (International Standard) 1996 recommended these as "allowable community LAeq dBA noise LIMITS" (These are NOT Background noise levels).

District Type	Day (7AM-7PM)	Evening (7PM-11PM)	Night (11PM-7AM)
Rural	35	30	25
Suburban	40	35	30
Urban Residential	45	40	35
Urban mixed	50	45	40

However, they comment: As wind turbines are mostly in rural areas, a level of 25 dBA is very difficult to achieve, which is why the most stringent regulations currently in force recommend a limit of 35 dBA in sensitive noise areas. Textbook author's direct quote: "However, this limit is too high for many residents so 30 dBA Lmax may be a reasonable compromise for the maximum allowed noise at the exterior of rural residencies". They listed several recommendations from the 2008 Kamperman and

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James publication. To determine background noise, precise standard conditions were specified: LA90 is determined using several 10-minute measurements during the quiet night hours between 10 PM and 4 AM when the wind is blowing slightly (<2 m/s at 1.5 m above the ground) from the wind farm to the residence and the wind farm is NOT operating. Daytime levels can be 5 dBA higher.

### 3. Adjustment for Uncertainties

Any noise level calculated using a generally accepted propagation model with down-wind conditions (not turbine design) included, should have 4 dBA added to the calculated level to account for uncertainties in turbine sound powers and uncertainties in the propagation model parameters. Examples of under-prediction of wind farm noise levels are presented.

Despite “uncertainty adjustments”, regulation that clearly state a Lmax value (at any time day or night), subsequent post-construction measures of emitted IWT turbines that exceed that discrete Lmax level are not in compliance and should be shut-down or substantially limited via NRO Programming from the SCADA unit while verification of non-compliance is obtained using independent, non-biased, certified acousticians who have access to the SCADA data at the time of the complaint. It has been recognized by extremely experienced, IWT-specialist acousticians that “routine” monitoring of turbines operating at least at “half-power”, measures to excess noise production above limit averages 8dBA and can be as high as 12 dBA. Insisting absolute compliance or face marked power reduction reprogramming or turbine removal if compliance cannot be obtained, has and should be a part of a protective ordinance.

### 4. Maximum Allowed Calculated low-frequency noise level

Maximum allowed calculated low frequency noise level in the range 10-160 Hz should be less than 25 dBA at the exterior of non-participating homes with a 4 dBA allowance for calculation uncertainty, so the calculated level is actually less than 21 dBA. There are also DEFRA guidelines for the 1/3-octave band unweighted noise (Leq) that were exhaustively developed to avoid annoyance. This is a very important aspect of health protection - particularly as IWTs are rapidly increasing in size and power capacity - both directly related to increasing amounts of ILFN production. Limiting total turbine height to <500 feet should prevent introduction of harmful excessive ILFN. Please note above, the use of dBC Lmax language.

### 5. Accounting for Multiple Wind Farms

There should be the requirement that takes into account the development of more than one wind farm in the same general area. the existing ambient sound level should be the one that existed prior to construction of the first wind farm.

### 6. Determination of a Compliance Testing Method.

Detail of such testing are complex and could be referred to. Cost to be borne by wind developer.

**7. No Change to Turbine Model.**

The wind farm developer should not be permitted to change the turbine model after development approval has been given without undertaking another noise prediction study with the new turbines. If the resulting sound levels at any residence are higher than originally calculated, an amendment to the development approval should be sought. Again, a maximal height limit of 500 feet should be enforced and will be necessary to prevent introduction of more dangerous and larger models of IWTs.

**However!** I have recently learned that MAE is “re-tooling” prior towers with longer blades (forcing the separation from ground to lowest excursion of blade to be shorter) thus allowing a greater “swept area” and a larger power generation capacity. As such, given the risks of ILFN as a concept, the subsequent increased noise emissions (particularly of ILFN) of the higher capacity IWT), and no way to limit emissions except through greater separation of IWT from property line/home, it should be stated that the replacement generator cannot be of a greater energy generating capacity than was the original sited turbine.

**8. Acoustic Study Funding**

The government body responsible for compliance assessment (should be funded by the wind farm developer) to choose and hire an acoustic consultant to do the testing **independent of any influence from the developer.**

**9. Decommissioning Costs**

Although not related to noise, it is important that any regulation specifies a required upfront payment for decommissioning (of the order of \$350,000 per turbine in 2011, and \$625,000 in 2018). This should be put into a long-term investment account or bonds, as it is likely that the company installing the wind farm will not exist when its design life expires (usually 25 years). Periodic reassessment (? every 3 years) of projected decommissioning expenses should be made and the current wind farm owner should produce additional funds (within 2 months of estimated additional cost) necessary to fully cover any decommissioning expenses. This is particularly important as turbine component recycling and removal/disposal may very likely become more rapidly expensive than other “costs of living expenses”. This is a difficult point, but assuring (without any ambiguity) that adequate funds are available to remove, safely dispose of all components of the IWT and restore the land to its “original pre-turbine state” is essential. The values listed above are from one Midwest wind farm. Wind Energy may state that components could be recycled to offset any “bond posting”, however, the monies realized through turbine part recycling is a very small percentage of the total costs of decommissioning.

**10. Property Value Assessment**

The value of properties within 5 km of a wind farm should be assessed by an independent commercial property assessor appointed by the local council prior to construction and the difference between that valuation and any sale price achieved within one-year post construction should be paid to the resident by the wind farm operator at the time of sale. Alternatively, if the property cannot be sold for a reasonable price, the wind farm operator should be required to purchase the property at the market

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value prior to construction of the wind farm. This would not apply to owners having the property in easement with the Wind Developer nor to any landowner who does not wish to have an appraisal of their property.

#### 11. Existing Noise Ordinances and Regulations

These should be listed and the wind farm operator should be obliged to be in compliance with those existing sound ordinances. Normally those are listed as a part of the Comprehensive Plan which also has instructions for compliance.

#### 12. Clarification of Modeling Considerations:

Models of wind turbine utilities used for assessing land use compatibility should:

- 1) Recognize the research of the NASA reports and other research that wind turbine infra and low-frequency sound must be handled differently than mid and high frequency sound
- 2) Be the best suited for representing wind turbine sound propagation
- 3) Represent the **Predictable Worst-Case Condition**
- 4) Fully disclose assumptions, limitations and tolerances of any modeling calculations
- 5) Provide confidence limits to account for the inherent inaccuracy in any model representing a complex set of conditions.

#### 13. Outside Independent Review of Proposal Prior to Beginning Construction

As noted, there are lots of complexities of modeling of IWT siting to protect the health, safety and welfare of affected residents living in/near the proposed wind industry location. The lives and lifestyles of those affected will be forever altered as well as for subsequent generations that may reside there for use that land. They deserve the right to have the opportunity to have project proposal reviewed by an **independent** engineering firm (selected by the citizens) with half of the cost born by the county and half by the affected residents. The reviewing engineer must be a member of the Institute of Noise Control Engineering. The INCE Member has experience in noise impact assessment and control (complaints, annoyance, noise specs) and is committed to the Canon of Ethics. With regard to industrial noise, experts would have to demonstrate their commitment by oath or experience to protecting the safety, health and welfare of the public from industrial and power generation noise pollution.

#### 14. The Bottom Line

Obtaining and reviewing recently developed "protective (to health)" enacted wind ordinance examples is crucial. The ordinances are written in such a way as to be easily transferred into other, developing ordinances. As noted elsewhere, there are NO federal and in most cases state-level experts that can help individual township or county-level citizen or non-captured Supervisors as they will invariably

struggle to produce protective ordinances. In addition, any templates from Wind Energy or captured administrators or Supervisors will often include "preamble" verbiage to the effect that ordinance HAVE to be constructed that both protect residents but do not discourage wind turbine investments. That is IMPOSSIBLE. Wind Ordinances should be aggressive to fully protect the health, safety and welfare of the residents who will be living and sleeping nearby. Once safe "human-compatibility" safeguards are established and described, if a prospective Wind Contractor feels he can abide by that regulatory language, then it could be a win-win situation. My experience is that to achieve mutually agreeable but otherwise opposing requirements will be very difficult VERY difficult: Once Administrators or Supervisors have compromised human health protection; they have violated the trust of the citizens that elected them and have violated their oath taken to protect the residents of their county.

IT IS MY OPINION, that IWTs have become so massive and generate significantly dangerous and harmful noise emissions (that have never been proven to be safe ... with that obligation being born and to date "ignored" by the "polluter" i.e. Wind Energy or its contractors) that they cannot be safely deployed in most rural residential areas. It is "curious" in that recent promotional television or paper ads for wind energy production have, over the last two years, largely eliminated any "semblance" of nearby human habitation or activity. It is almost as if Wind Energy is beginning to understand what they are "doing" to people.

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**Part – 14: Summary**

**Brief, High-Level Summary:**

IWT = industrial wind turbine

AHEs = adverse health effects

ILFN = Infrasound, low-frequency noise

WHO=World Health Organization

MAE=MidAmerican Energy

In this lengthy section, there is an expedited review of 13 parts (separately chaptered) and sequentially combined to highlight important concepts. These will make reference to available additional data and relevant information that could be accessed with a specific review of that "part". In the front, there is a Table of Contents that will facilitate more rapid focusing to your requested data. Some portions of this summary are from the individual parts directly copied onto the Summary. My goal in beginning this data collection was to discover the "truth" in this highly contentious topic. It was immediately apparent that too little information was being made available from MAE and that the County resources had very little understanding of the implications of these turbines. I have attempted to learn the vocabulary and the concepts behind Wind Energy noise and focused, specifically and intensely, on adverse health implications. Having attended nearly all of the county-level meetings related to the proposed Arbor-Hills wind farm development by Mid-American Energy, it was immediately obvious that that two dramatically different interpretations of this data have evolved.

Review of imprecise definitions, different assertions, conflicting peer-reviewed data and major studies on IWT noise initially failed to clarify why there is such a difference in interpretations. I was then able to contact directly some of the key (literature) authors and ask my questions that led to the origins of international guidelines of turbine siting (e.g. ETSU-R-97) and ask if the principles they were founded upon still made "scientific sense". There were individual acousticians who were pivotal in the pro-Wind faction who initially described IWT noise in a very different "light". It is a remarkable trail to follow and to finally understand. My background in caring for patients and specialization in Cardiology and arrhythmias with a relatively recent recognition of untreated obstructive sleep apnea causing cardiovascular disease (seen repeatedly in my clinics) allowed me "confidence" to explore IWT noise and the development of possible chronic cardiovascular disease as well as other forms of "harm". Published data in early 2019 of two studies that reported a link of sleep duration and cardiovascular disease - one clinical disease manifestation and the other showing objective increases in atherosclerotic disease progression in those populations with less quantities of sleep were pivotal in recognizing that environmental noise that seriously affect sleep - in quantity and quality - CAN cause serious health effects. Importantly, wind turbine noise is more "annoying/bothersome" than the other three WHO-



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tracked environmental noise sources making the premise that IWT noise is likely harmful to health almost undeniable.

The content of this data collection is not peer reviewed as an entity. Nearly all of it comes from peer-reviewed data and publications. My conclusions are supported by many sources and through many lines of logic. I have directly transferred published information from sources which I have referenced in the text into the paragraphs of the various document "parts". Currently, there are no plans for publication of this information (I do not have the time) but may make it available to readers on the Internet.

In the final view, the conclusions are mine being supported by the cited publications and from reputable professionals with vast experience in this area. Absolutely relevant and important "conclusions - made by me" about various organizations and individuals as I have come to "understand them" represent MY OPINION. I wish no malice toward anyone or entity. I just wanted to know "the best discoverable approximation of truth" so that I feel comfortable with my comments and conclusions. I take my responsibility as a health care provider in my community seriously and personally; I appreciate the respect and time you have given me and the TRUST in me that it shows. I have received no financial return in this extended endeavor.

### **Introduction - Part 1**

This was a communication to the Madison County Board of Zoning in anticipation of reviewing Wind Ordinance elements. I will refer the reader to pages 17-19 where that "letter" can be found.

### **Part 2 - Sleep**

The majority of the industrialized world struggles to obtain adequate and restorative sleep. Inadequate sleep begets mental and physical stress which may beget chronic mental and physical disease. Disturbed sleep is the most concerning adverse health effect from industrial wind turbines. It may arise directly from the sound emissions of IWTs or may result from other forms of adverse health effects (AHEs) generally termed as annoyance. ANY annoyance (mild, moderate or severe) is considered to be an AHE. Sleep disturbance is the key to a cascade of adverse physiologic consequences that may, in the extreme, be associated with a host of potentially serious cardiovascular outcomes. While it is clear that such a relationship may exist - as judged by the WHO -from exposure to automobile and train and aircraft noises, the data is not robust enough to confirm the same concerns with industrial wind turbines although there is accumulating data to support that association. It is worthwhile reviewing the process and importance of sleep. Recognizing the profound implications of turbine siting distance from homes to lessen the consequences of sleep disruption should be a primary focus in creating a protective Wind Ordinance for affected residents.

Sleep is composed of transitioning through various stages. Non-REM (Non-Rapid-Eye-Movement)

sleep typically occupies 75-80% of total sleep each night. This period provides time for essential brain function recovery - tissue growth and repair, energy is stored and hormones that are essential for growth and development are released. REM sleep typically occupies 20-25% of total sleep each night. This phase is when dreaming occurs, is essential for processing and consolidating emotions, stress and memories. It is reportedly vital for learning and stimulating the brain regions used in learning and new skill development.

Non-REM sleep (also termed slow-wave sleep) transitions through 3 successively "deeper" sleep levels during the night with transitioning to increasingly longer and "deeper" REM periods occurring toward morning. If the REM or non-REM cycles are interrupted multiple times through the night (either as brief, non-conscious arousals or as periods - however brief - of "full" awakening) then we may fail to reach the "deeper" periods of sleep where these "recharging events" can occur. As stated by the National Institutes of Health, "Sleep effects almost every type of tissue and system in the body - from the brain, heart and lungs to metabolism, immune function, mood and disease resistance. Research shows that a chronic lack of sleep, or getting poor quality sleep increases the risk of disorders including high blood pressure, cardiovascular disease, diabetes, depression and obesity".

Your need for sleep and your sleep patterns change as you age and this varies significantly. Babies initially sleep as much as 16 to 18 hours per day which may boost growth and development (especially of the brain). School age children and teens need about 9.5 hours of sleep per night. Generally, adults need between at least 6-7 hours. After age 60, nighttime sleep tends to be shorter, lighter and interrupted by multiple awakenings. Elderly people are also more likely to take medications that interfere with sleep. For these reasons, our younger and older county residents are considered more vulnerable in their age-related obstacles to achieve restorative sleep. In general, people are getting less sleep than they need due to longer work hours and the availability of round-the-clock entertainment and other activities. The idea of "catching up" on weekends actually never can be fully achieved.... although one may try; "sleeping-in on weekends" has been recently associated with heightened degrees of insulin resistances measures than simply returning to a normal sleep pattern.

We are a society plagued by increasing obesity (now about 40% of Americans are considered as obese with 7.7% being severely obese). The American Heart Association has now included obesity and severe obesity in children as cardiovascular risk factors. With the recent redefinition of hypertension going from 140/90 to 130/80 now >46% of American are considered hypertensive. The incidence of type II diabetes (the type related to "high" insulin levels due to acquired resistance of insulin action at the cellular level) continues to increase in incidence. Somewhere in this "modern health epidemic" is the problem of sleep quality and quantity. The 2019 Annual statistical update from the American Heart Association included a new section on sleep and cardiovascular health citing data from the Centers for disease Control and Prevention that only 65% of Americans have a healthy sleep duration (at least 7 hours).

Inadequate or disrupted sleep is the most common complaint from residents living near IWTs. It is extremely important to realize that not only does excessive audible noise cause sleep disruption but can also occur with amplitude modulation from the ILFN noise spectrum. ILFN emissions can travel up to

3-4 km from IWTs to a household given certain wind and atmospheric conditions. Sleep is "disrupted" through both unconscious arousals and with frank awakenings - both disrupting the otherwise healthy progressions through both non-REM and REM sleep periods.

At the 1500-foot setback proposed by Mr. Clifton, **average** sound levels (expressed as Leq) will be 45 dBA (with the 2 MW IWT proposed by MAE) as measured outside the house as predicted by computer modeling. Forty-five dBA Leq means that there may be recorded peaks as high as another 6-11 dBA above the 45 dBA Leq average. Albeit much less frequent than the average value, audible sound levels of 56 dBA are possible. Of even greater concern are possible still higher noise levels yet - reflecting possible poor individual turbine siting's (with IWT clumping, in-line arranging along prevailing wind axes, intermittent turbulent wind conditions or period of significant temperature inversions and other reasons). Turbine separation modeling occurs with the IWT model stated sound power level which reflect sound production with optimal winds and not "worst case scenarios"). Testimony under oath by Wind Energy representatives have confirmed these possible noise ranges that are expected from IWT sources. It also means to achieve bedroom levels of 30 dBA your windows will need to be closed tightly with all exterior audible sound not exceeding 45 dBA. Opening the bedroom window even a little (cracked 6 inches) for cooling or fresh air circulation will markedly increase noise entry into the bedroom - enough to necessitate IWT separation another approximately 2000 -3000 feet farther to reach 30 dBA sound levels inside.

ILFN poses an even greater threat to sleep disruption. Infrasound generally attenuates (lessens in loudness) at half the rate as does audible sound. This means that (roughly) to achieve the same reduction in noise levels for audible sound, you have to go twice as far (in setback) to achieve the same noise level with infrasound. Infrasound travels to some extent by resonating in the ground that can then easily resonate a house foundation and structures within the house - being insignificantly lessened by wall/roof insulation. Infrasound "sound travel" is frequently described as "amplifying" in the house. Low frequency sound also attenuates at rates less than audible sound ranges - intermediately as compared to infrasound. Low-frequency noise is audible being 40-60 dBs in the 20-200 Hz range. This would be hard to ignore without sound protection equipment (ear plugs). The sounds in that frequency range are heard/perceived by people in their beds at night when the house is otherwise quiet as "vibrations", rumble and roar. While not particularly "loud", they are perceived because in the rural residential environment there are no other noises in the community to provide masking of these low frequencies. It is for that quality of quietness and solitude that the residents chose to live there.

### **I Have Seen the "Face" of IWT Harm**

Three years ago, while inquiring about used farm machinery, I sought out a farmer who lived nearby in Guthrie county. Arriving at his farm perched along the "Mo-Miss Divide", I was fascinated at the distracting "surging" of spinning IWTs "for miles". Greeted by the farmer, I asked him about how "he and the turbines" got along. He noted that "a lot of people had moved away, and over half of those who agreed with their easement signing now regret having done so." Looking into his face, I could see the likely signature of chronic sleep deprivation (a distinctive appearance that I can easily recognize in those sent to me for atrial fibrillation consultations who have concomitant obstructive sleep apnea).

His speech was a bit halting and searching.... I asked how his sleep was and whether he thought the turbines had created a problem sleeping. Looking inward, he paused, then scanned the ongoing turbine "wind chopping" and looked down then back up at me. "I don't think so... maybe you get used to it. A year ago, I built a new bedroom addition to my house putting in the best materials I could find with 2x6 construction, thicker insulation and heavier sheathing. It made it better.....(he paused) ...but on those windy nights I can still hear and feel that pounding...." I sensed an exhausted man who had resigned himself to "deal with it". He was imprisoned on his own farm with his entire livelihood around him.

### **Part – 3: Wind Turbine Noise - Basics**

This part contains the conventional divisions of the sound spectrum. Hz = "hertz". One Hz is equal to one cycle/second, being a unit of "frequency". The greater the Hz value, the shorter the wavelength of the propagated sound. Infrasound is very remarkable for relatively long wavelengths which occur at frequencies of < 20 Hz (cycles per second).

Infrasound: 0.1-20 Hz

Low-Frequency Sound: 20-200 Hz (The lowest key on a piano resonates at 27 Hz)

Audible sound: 20-20,000 Hz

ILFN: Term combining infrasound and low frequency sound.

Unwanted sound is termed "noise"

Weight filtering reflects the "loudness", or "sound pressure level" as recorded within a certain frequency range. They come in multiple designations with "A" filtering being, by far, the most commonly used, which is "centered around" about 1000 Hz. It captures most conversational sound frequencies but, by virtue of the filter designed limitations, is unable to reflect (quantitatively) ongoing low frequencies (such as infrasound). On the other hand, the "Z" filter is "unweighted" and a stated value reflects sound levels combined for all frequencies being measured (e.g., by a microphone).

The industrial wind turbine creates sound from multiple sources: machinery noise in the nacelle (where generator is working behind the hub), the blades moving through the wind causing "blade swish" as air moves around the blade itself, and low frequency (still audible) noise from the blades due to in-flow turbulence - often around the tower. Impulsive sound is generated in the infrasound sound (usually at frequencies just under once/second) that reflect the "blade pass frequency". It is "recognized" not as a tone but as a "cyclic pressure wave" appreciated by the inner ear.

Turbines have both down-wind and up-wind designs reflecting whether the turbine blades are down-wind or up-wind of the supporting tower. Both designs were very thoroughly evaluated by NASA/Boeing joint-funded investigations - primarily associated with N.D. Kelley's work (but there were

several others who also contributed) in the late 1980s. Down-wind designs were intrinsically "noisier" and led to the current commercially-used upwind designs that produce less infrasound and audible noise.

Amplitude modulation involves air turbulence around the turbine blades and noise interactions with other turbines as well as other sources.

The (3) turbine blades are attached to the hub which is at the top of the tower. These blades can be rotated at that connection changing the fixed canted blade angle with respect to the air inflow interacting with the blade edge. The blades are rotated to achieve the greatest "air purchase" which then effects the efficiency of power production. Greater blade angle rotation can cause more noise production with VERY significant amounts of 11 dBA or more.

The "character" of noise created by IWTs has been described as "distinctly annoying". At a given A-weighted level, it is far MORE annoying than airport, truck traffic, railroad or industrial noise - due to special audible and inaudible modulated and tonal (distinct - sound) characteristics. The noise is often of low amplitude and shifting in character - such noise quality resists "habituation" (getting used to) and hence dramatically can frequently, in an on-going fashion, perpetuate suffering of annoyance. Of special importance is that IWT noise can be easily appreciated at up to 10 dBA BELOW background noise.

Computerized sound propagation models are imprecise, to say the least. There are so many ongoing variables that can influence sound transmission - certainly the weather, but also terrain variations among other factors. Consultants (including Mid-American Energy) claim to have very sophisticated modeling equipment (which they may have) BUT their siting of IWTs in adjacent Adair county (in rows, spaced closely together, particularly at short distances to inhabited residences (500 meters) is prone to calculational noise level errors. Errors in models of IWT noise propagation located on flat terrain have been shown to have errors of 5-10dB when studied by independent acoustical engineers. A sound level of 10 dB above an estimate represents a roughly doubling of the perceived "loudness" of a noise. Of great importance at the initial public courthouse presentation by MAE was the **absence** of a stated sound level that MAE was trying to not exceed (they only had a setback distance on their original Madison County "variance" request). Matt Ott, (apparent MAE engineer) with great imprecision at the time of variance request presentation stated (with hesitation and implied uncertainty) that noise levels at the "the front door of an occupied residence would be 45 dBA (Leq) and that it would be "safe".

"Worst Case Conditions" (to this writer) should represent the highest (loudest) sound levels ever heard/recorded at the receptor, e.g. property line. A lot of these "discrete, infrequent" episodes may occur at night during higher winds as can be associated with wind shear, temperature inversions or other events. Typical computerized calculation of sound levels is from the stated "sound power level" of a given turbine model. That rating, in terms of loudness, is done with steady winds. Such characterization of rated sound production is significantly lower than what could be produced by the IWT during periods of wind shear, blade angulation, or to other, not-infrequent "worst case scenarios". I believe that IWT siting should be within 5 dBA of the worst possible noise levels that could be

experienced and that level should be signified as a Lmax sound level. Any proposed wind farm "siting map" should state all assumptions and predict worse-case scenarios within 3 dBA. If they are not certain, turbines and residences should be more widely separated to avoid noise compliance penalties.

**Part - 4: IWT Sound Emissions, Types -**

Wind turbines produce infrasound along with low-frequency and audible noise. The more powerful the wind turbine, the greater the proportion of infrasound and low-frequency noise that is emitted. Sound with frequencies below 20 Hz is labeled as infrasound. With its initial (historical) "labelling" it was described as not being able to be heard, but with greater scientific investigation, it actually **can** be heard at the higher end of the 20 Hz zone while "perceived" at the lower portions provided the sound pressure level is sufficiently high. The sound is perceived with the ears usually giving a feeling of pressure at the eardrums. Infrasound at an audible level is usually found on the car deck of a ferry and when driving a car with an open window. Infrasound is most often associated with sound at other frequencies, so the experience of listen to "pure" infrasound is uncommon.

The recent rapid introduction of IWTs into rural residential locations at close siting to resident structures of increasingly larger IWT for the purposes of larger energy production per turbine has been without ANY efforts by Wind Energy (as I can see or should have been told) to ensure public safety. These larger-sized turbines with reported production capacities of up to 4.8 MW have similar sound profiles - particularly in the infrasound range BUT produce sound levels that are higher along the ILFN sound spectrum. It has been pointed out by multiple acousticians (Moller, Kamperman) that the levels of sound (loudness in dBs) increase by 3-5 dB for every MW of electrical power generating capacity. Wind Energy disputes that IWTs produce little, if any, appreciable infrasound. As stated, originally, acousticians were taught that human thresholds for hearing were much lower (i.e. unable to detect) than the typical sound levels produced by IWTs. A lot of scientific and peer-reviewed data has changed that original understanding. In all my readings, I have seen zero rebuttals, comments, critiques or expressed outrage by Wind Energy to any of these newer concepts as collectively they further challenge a fundamental tenant Wind Energy: denial of adverse health effects of ILFN.

- 1) In the 1970s, structures within the inner ear that allowed low frequency detection were recognized
- 2) In the 1980s, it was recognized that inner and outer hair cells possess dissimilar mechanical properties. Alec Salt demonstrated that the outer hair cells can be up to 40 dB more sensitive than the inner hair cells at 1 Hz.
- 3) Original hearing thresholds were defined by recognition of "pure tonal" sound whereas the real-world IWT sounds are more impulsive and varied. As the human ear "reaches" to embrace detection of IWTs, noise recognition can extend another 10-perhaps 15 dB lower.
- 4) Additional enhanced hearing detection in "some individuals" may extend another 10-12 dB lower.
- 5) Unique (but clearly demonstrated in "sensitized" individuals) capabilities of hearing or perceiving "so-called harmonic peaking of the blade pass frequency" during "heavy winds" has been noted and has

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been personally recognized by prominent acousticians.

6) Additional "sound recognition" through heightened tactile detection of vibration is possible

7) Finally, very recent demonstration of "brain recognition" yet not "cognitively perceived" infrasound has been documented during "functional" MRI imaging as seen with activation of "key autonomic brain centers" during sub-thresholds infrasound stimulation. (Max Planck Institute, 2019)

The full extent of our body's recognition of infrasound IWT emissions is incompletely characterized but as IWT noise is more "annoying than traffic, rail or aircraft noise" with these latter noise sources now associated with promoting cardiovascular disease, a reasonable and scientifically grounded individual should be very concerned about yet another environmental risk. Basner and McGuire (2018), published "WHO Environmental Noise guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep". While they acknowledged the "incomplete state" of supportive research regarding IWTs and cardiovascular disease, they did comment "There is biologic plausibility that chronic nighttime exposure to relevant levels of noise can contribute to negative health consequences like cardiovascular disease". They did add, importantly, that "disturbed sleep has immediate next-day consequences (e.g., increased sleepiness, impaired cognitive performance) that may increase the risk for errors and accidents, and thus sleep deserves protection from noise even in the absence of a direct link to long-term health consequences. This is particularly concerning given the projected future decades of IWT exposure and a likely mechanism for triggering cardiovascular disease (#7 above).

In the 2018 WHO Environmental Noise Guidelines, their concern of IWT sound level exposure (based on the available research) generated the recommended reducing noise levels produced by wind turbines below 45 dBA<sub>Lden</sub>. No specific nighttime level was given. With "less annoying sound sources of road traffic, railway noise and aircraft noise, L<sub>den</sub> were 53, 54 and 45 dB respectively with nighttime levels of 45, 44 and 40 dB respectively.

Low-frequency sound and annoyance are also described in more detail within Part - 4. Of particular visual intrigue is the ongoing display (Link provided) of modulated low-frequency noise presented by Dr. Cooper at a 2017 International Commission of Biological Effects of Noise.

Annoyance **IS** an adverse health effect (AHE) as defined by multiple references (including the WHO) listed in the Conclusion section. Annoyance creates AHEs and with that suffering and a host of relevant health (physical and psychological) consequences. Wind Energy would argue that annoyance reflects a purely negative "attitudinal" response from the appearance, sound, financial implications and other factors that then produces the "annoyance". Such non-direct suffering by residents in wind farms has been rejected by nearly all except Wind Energy.

## **History - Part 5**

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This section is immensely important as it supports the scientific data that IWTs cause AHEs but also provides a trail to where the current harmful Wind Ordinance draft proposals originated. Also, it describes the setting where wind turbine manufacturers entered the regulation process and continue (in their protected and "facilitated" state) to introduce harmful noise into our communities.

The focus on community noise (unwanted sound) began (mostly) in the 1970s with the evaluation of low frequency audible and perceived sound associated with industrial compressors and turbines. Later, "sick buildings" were evaluated by highly trained acousticians who found HVAC installations were the source of vague complaints **with and without** noise recognition. Some of the symptoms experienced included mental tiredness, lack of concentration, and headaches were associated with reduced work performance and work satisfaction. Not all the workers complained of symptoms or even audible rumble. It required special studies and tests developed by Dr. Leventhall and others to identify that the workers' sense of being uncomfortable or having other symptoms while in their offices was associated with the modified ILFN. These investigators convincingly showed that pulsations in the HVAC systems corresponded to times when the workers reported symptoms of mental tiredness, lack of concentration, headaches and reduced performance and work satisfaction. Importantly, subsequent research revealed a host of closely-matched symptoms that are reported by those experiencing adverse health effects from IWTs.

Apparently, Dr. Leventhall, despite his early clear research and clarification of ILFN being responsible for symptoms closely mirroring those from IWTs, in the years to follow, uniquely and inexplicably chose to develop and support Wind Energy's stance on the "benign" character of ILFN produced by wind turbines. He became a champion and referenced leader in Wind Energy's promulgation of IWTs around the world.

Previous research had shown that at AUDIBLE levels, ILFN was able to produce physical responses. However, many scientists and engineers assumed that inaudible levels could not cause any problems. Indeed, Mid-American Energy (MAE) representatives in our Winterset Courthouse during the 2018 permitting process, repeated the saying "what you can't hear, can't hurt you". Many acoustical engineers were taught this as a part of their academic training regarding the perception of ILFN. Subsequent studies by researchers such as Swinbanks, Ebbing and Ebbing's colleague Blazier, an independent acoustical consultant who worked in the HVAC industry, found evidence that SOME people responded to INAUDIBLE levels of ILFN produced by the machines.

Dr. Malcolm A. Swinbanks produced a nice review of this topic when presenting to the Australian Senate Select Committee on Wind Turbines on March 20, 2015. As noted in the previous paragraph that it is important to see IWT noise as "impulsive and complex".... mean levels of sound fail to take into account either the character of the sound or the relationship between adjacent frequency bands. He also referenced a number of reported cases in the literature where ILFN was clearly being perceived at significantly lower levels than would be assessed by such basic comparisons with the hearing threshold.



He summarized that "conventional hearing perception" is considered to take place via response of the inner hair cells of the cochlea (the sensing structure of the inner ear), but it has been shown that the cochlea outer hair cells respond with greater sensitivity at very low frequency, and induce additional neurological signals. Hitherto, these outer hair cells have been considered to perform only the task of controlling the overall sensitivity of the hearing process, but it is possible that they can also contribute directly to very low frequency perception". He continued with "a further mechanism has been proposed, whereby sound pressures acting through the lymphatic fluid directly on the otolith components of the vestibular (balance) organs have been calculated to exert comparable forces to those induced by motion and acceleration. Any non-uniformity in the compliance of the structures supporting these otolith sensors may then result in a response which is that of physical motion. Indeed, it has been argued that the correlation between persons who suffer from motion sickness and those who report adverse effects from wind turbines is sufficient to be more than a result of mere chance". Of note is that a resident from NW Madison County, who turned west onto I-80 was faced by a horizon of revolving turbine blades. She soon thereafter felt sick, nauseated and vertiginous enough to be forced to stop her car on the side of the road, attempt to recover, and then proceeded off at the next exit.... eventually recovering upon exiting the turbine field. That same sensation has been noted by others with the above mechanism likely explaining her symptoms.

The U.S. government has known about health effects of infrasound and low frequency noise from wind turbines since 1987. It was concerned enough to commission a study. The study was a research project funded by the U.S. Department of Health, Contract No. DE-AC02-83CH10093. Among many impressive scientific papers, was the following: Dr. N.D. Kelley, Solar Energy Research Institute, Golden, Colorado: "A proposed Metric for Assessing the Potential of Community Annoyance from Wind Turbine Low-Frequency Noise Emissions" Note: "Community Annoyance" is now called Wind Turbine Syndrome; "Low Frequency" includes infrasound; "Emissions" includes noise and vibrations.

Kelley et al, concluded: "...one of major causal agents responsible for the annoyance of nearby residents by wind turbine noise is the excitation of highly resonant structural and air volume modes by the coherent, low frequency sound radiated by large wind turbines. Further, there is evidence that the strong resonances found in the acoustic pressure field within rooms actually measured indicates a coupling of subaudible energy to human body resonances at 5, 12 and 17-25 Hz, resulting in a sensation of whole-body vibration." Additional investigation by Kelley, found that turbines radiated their **peak** sound power (maximal "SPL" or "loudness") in the infrasound range, typically between 1 and 10 Hz. Annoyance was the result of a coupling of the turbine's impulsive low-frequency acoustic energy into the structures of homes and that the annoyance was frequently confined to "within the home itself". In Kelley's and in three other investigators work, the studies report similar findings, namely that perception, generally is non-auditory in character, begins when the rms SPLs (loudness) of the modulating tones that are as low as 35 dB rms with increasing impacts as the rms levels rise to 50, 60 and to 70 db and higher. In all these studies the dynamic modulation of the blade-pass tones produces pressure peaks that are often 10 dB or more greater (sometimes much more), than the rms values.

**I would strongly recommend that this link be opened (find listed in part 5) and the history of the**

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recognition of infrasound and its potential for adverse health effects was first described by N.D. Kelley and how it was "forgotten or intentionally overlooked". Despite the recognition of potential human harm, this information was discarded by Wind Energy and specifically by the turbine manufacturer, Vestas, the manufacturer of turbines proposed for installation in Madison County.

Two primary researchers, Hubbard and Shepherd (1990) (**30 years ago**), reported the following:

- 1) Wind turbines produce primarily infrasound and low-frequency sound.
- 2) Sound propagates from IWTs at a decay rate half that of common (audible) "point" sources
- 3) IWT noise travels farther than other sounds.
- 4) IWT noise will be a significant indoor noise problem due to room resonance and a dominance of ILFN acoustic energy.

Fifteen hundred (1500) feet was the distance (in the original Mid-American Energy (MAE) request for siting of IWT from rural residences for the proposed Arbor Hills Wind Farm. At none of those initial and none of the subsequent follow-up meetings at any level was there a description of how that distance was proposed, how long it had been in use nor ANY description about the human health implications of that distance. Otherwise, in the written proposal, there was no listing of the anticipated noise exposure level to residents. Some of the presenting MAE representatives were not clear as to which model of IWT was planned for Arbor Hills (i.e. suggesting they do not link MW -rating with sound level productions). The only mention of noise levels incurred by the IWTs was the verbal comment (during the meeting) by Matt Ott (MAE) that he anticipated no more than 45 decibels at the front door of an occupied residence. He claimed that it was a safe level. Fifteen hundred feet setback was the only specification in not only Madison County's proposals but also that of Adair County and any proposal IWTs that I have seen for Iowa. So where did it come from?

Noise regulation in the United Kingdom was "originally" via the British Standard BS4142 (described as "method for rating industrial noise affecting mixed residential and industrial areas"). A document described as the Planning Policy Guidance 24 (PPG24) was generated in the UK that outlined some of the main considerations which local planning authorities should take into account in drawing up development plan policies and when determining planning applications. PPG24 provides advice on how the planning system can be used to minimize the adverse impact of noise without placing unreasonable restrictions on development or adding unduly to the costs and administrative burdens of business. The document introduced the concept of noise exposure categories (NECs) ranging from A-D for residential development and recommends appropriate levels for exposure to different sources of noise. A proposal for residential development needed a determination of which NEC categories would be operative also taking into account both day and night-time noise levels. The PPG24 takes into account the recommendations of the Noise Review Working Party which reported in October 1990.

PPG24 - 1994 recommended using the British Standard BS4142. This regulation was formulated to assess facility external noise (outside at a property) **based on the likelihood of complaints**.

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Background noise levels (LA90) should be measured. Source-specific noise levels (rating level) are then obtained from manufacturer's data or measured in situ. The background noise level is then subtracted from the Rating Level. If there is likely to be a tonal content or "specific character" to the building services plant noise then a +5 dBA correction is applied to the Rating Level. This assessment method is only applicable to external areas. Assessment of excess value:

- 1) A difference of around +10 dBA or more indicates that complaints are likely
- 2) A difference of around +5 dBA indicates a marginal significance of complaint.

This is the same formulation as used in the United States ... as in the ISO TC/43.

This BS4142 regulatory limit was based on reasonable likelihood of complaint generations was too restrictive for IWTs **as wind turbines have no noise control options except greater distancing**. Other industrial facilities don't have this problem, because they can enclose machinery in buildings, use mufflers, duct wrapping, etc. As such, Wind Industry had to come up with a "guideline" that raised background noise levels with the definition of 'LA90 -10 min' and convince U.K. regulators to use that guideline instead of BS4142. (Unfortunately, the LA90-10min measurement is effective for broadband noise such as traffic noise but not when measuring intermittent noise as produced by wind turbines). And that is exactly what they did as they developed ETSU-97. BS4142 continues to be used for industrial permitting and apparently remains a thorn in the side of consultants working to permit wind turbines and promote more noise in rural areas.

### **ETSU-R-97**

ETSU-97 is a set of guidelines and not a set of regulations. The acronym stands for "Energy Technology Support Unit". **The ETSU working group was formed by the British Wind Energy Association for the purpose of preparing wind energy friendly guidelines and research.** In that capacity, it worked on behalf of the Department of Trade and Industry (DTI); generally, with no independent oversight and no transparency. "The Assessment and Rating of Noise from Wind Farms" was published in 1997 and remains the UK government's preferred method of assessing wind farm noise for planning purposes. Rick James (in his article "Wind Turbine Infra and Low-Frequency Sound: Warnings signs that Were Not Heard") described the "inadequate" design of the ETSU-R-97 which was a "guideline only" for the UK that was developed specifically to circumvent more science-based UK regulations that were more restrictive to IWT placement. The guideline was developed by the Working Group on Noise from Wind Turbines which consisted of several acoustical consultants with ties to the wind industry in the UK, representative of companies or their attorneys involved in or with the wind industry, several representative of local governments and the chairman, who represented the government's Department of Trade and Industry (DTI).

The introductory comments about ETSU's purpose to "offer a reasonable degree of protection to wind farm neighbors without unreasonable restriction on wind farm development" has been met with near universal worldwide contempt (as also occurred in Madison County during a joint writing session with the Supervisors) as the guidelines should not provide the justification to impose greater levels of wind

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turbine noise intrusion than would be permitted by other forms of development (or which could still produce human harm to nearby residing residents).

ETSU-97 compares the turbine noise with a level 5dB above background noise, but when background noise levels are low (particularly in rural areas), it sets a higher lower limit. The day time lower limit can be anywhere between 35 and 40 dBA and the night time lower limit is 43dBA. The most bizarre result is that night time background noise level can be "assigned" up to 8dBA more than the day time noise. No other standard anywhere in the world has a night time limit higher than a day time limit. There are a host of other concerns listed in Part-5 that are reviewed. Others, such as method of background noise measurement techniques, also exist but are complicated to explain.

It appears that the ETSU-R-97 was produced to permit introduction of wind farms into inappropriate low background noise locations where they and other comparable industrial installations could not meet planning conditions derived from the long established BS4142. It could be reasonably supported that the Department of Trade and Industry (DTI) worked with the British Wind Energy Association that formed the ETSU to develop "fuzzy-science" based guidelines. I would view this as "pseudo-science to support policy, NOT policy to support science". The ETSU is lengthy and complicated - intentionally so - and contains assumptions and omitted critical considerations. These included, among many, the existence and (already described) risks of ILFN and amplitude modulation, and allowed night-time audible sound levels to exceed those of daytime limits - all based on assumptions of background noise level changes at night associated with increased wind speeds. These guidelines were adopted and have remained largely unchanged over the last 23 years despite enormous increased understanding of IWTs physics and health effects.

After being informally adopted (but not approved as regulation) by the British government, British acousticians Hayes and later Leventhall were pivotal in the adoption of the ETSU-R-97 tenets - particularly to former British colonies (Australia, New Zealand) - being presumably sent to establish control of the narrative and establish a template that the local firms could subsequently use for other wind energy projects. Leventhall formally started his pro-Wind energy work when he became a spokesperson for the British Wind Energy Association in the early 2000's after Dr. Van den Berg published his thesis "The Sound of High winds" and two other papers that observed wind turbine blades create pressure pulses as the blade passes the tower. For the next 15 years, reportedly at the request of industry trade groups, Leventhall and others organized "international" wind turbine noise conferences where research was promoted and reviewed that reflected the Wind Energy vision. Hayes (British acoustician) apparently consulted on a project in New York state in the mid-late 2000's where working with US consultants reportedly "borrowed ETSU concepts" to get their projects approved in later projects. Those "templates" reportedly initiated by Hayes were "used around the world" being only changed to accommodate regulations. It is highly likely that such "original" language perpetuates to this day; with the various "Wind Energy Associations" sharing the recipe to Wind Energy Industry - a great many of whom sit at the Wind Energy boards.

Meanwhile, interest and evolution of power production through wind conversion energy systems continued with continued evolution of turbine size to accommodate higher production capacity and

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progressive interfacing into rural residential areas of the U.S.

Madison County Supervisor Aaron Price stated, in a prior county meeting, something to the effect that the Federal government would not have allowed IWTs to become so "widespread" if there was some inherent risk to human health. The unspoken fact is: There is **NO** regulation of IWT by the federal government. This fact, in the course of my reading, remains completely unaddressed by Wind Energy; they get to define if IWTs are safe or not and convince local counties in Iowa that they are OK. They have found that financial incentives seem to facilitate adoption of IWT placement - both for the landowners and the county tax rolls.

The U.S. Environmental Protection Agency (EPA) created the Office of Noise Abatement and Control (ONAC) following enactment of the Noise Control Act of 1972. In 1981, Congress agreed to the Reagan Administration's proposal to cease funding for ONAC. Congress, however, did not repeal the Noise Control Act when it eliminated ONAC's funding.

Before its elimination, ONAC engaged in a wide variety of activities to abate noise pollution under authority of the Noise Control Act and, after 1978, the Quiet Communities Act.

The Quiet Communities Act of 1978 amended portions of the 1972 Noise Control Act to require coordination between federal agencies on noise control. It was intended to speed up FAA response to noise regulations proposed by the EPA and required the FAA to provide the public with a detailed analysis of EPA proposals. These included identifying sources of noise for regulation, promulgating noise emission standards, coordinating federal noise research and noise abatement, working with industry and international, state and local regulators to develop consensus standards, disseminating information and educational materials and sponsoring research concerning the effects of noise and the methods by which it can be abated. It also authorized the EPA to provide grants to state and local governments for noise abatement.

The EPA ceased most noise abatement activities after ONAC's funding was eliminated. There is still some minimal enforcement in the area of airport noise. Responsibility for the enforcement of EPA's railroad and motor carrier emission standards was shifted to the Department of Transportation.

Since defunding ONAC, federal noise emission and labeling standards have not been subjected (best I can find in the internet literature) to critical evaluations despite the evolution of relevant science and technology and a better understanding of the effects of noise on people. The EPA has been unable to provide technical assistance to state and local governments or to participate in private, standard-setting efforts. State and local governments have been preempted from adopting their own noise emission and labeling standards that differ from EPA standards for sources or products that EPA has regulated. Apparently, there were never any EPA standards or regulations for industrial wind turbines. State and local governance has had to pick up that protective effort... but as said many times... without funding or other vital resources to do that. Specifically lacking are technical resources and highly trained engineering specialists to understand the science of industrial wind turbine sound emissions and interpret and stay current with the rapid explosion of our understanding of those sound emissions

causing adverse health effects. Unfortunately, relying on Wind Energy and the Wind industry for objective knowledge and guidance in protecting human health has never happened. In my opinion, executing their agenda has, by necessity, eliminated their concerns of protecting human health.

Currently, control/monitoring of IWTs is mostly at the county level (as it is in Iowa). However, in some states, it is regulated at the "state level". Such governance levels lack the funding and personnel resources to adequately protect threatened residents. Over the past twenty years, the wind industry has presented "their" evidence implying that IWTs are "safe" near people's home. Yet the reports of nearby residents suffering annoyance, sleep disturbance and the consequences of chronic non-restorative sleep and body/vestibular responses have been received from people living within 2 or more kilometers of IWTs not only located in this country but in countries around the world. Responding to this suffering of the affected residents, individual scientists and acoustical engineers, citizen groups, national and international action groups have developed to counter the "effective playbook" developed in the wake of ETSU-R-97's acceptance and current twisted/mis-information provided to the targeted "unsuspecting" residents by Wind Energy and their industry developers.

Aside from individual acousticians and appropriately trained independent engineers and researchers, most of the safety information is provided to that governance level by Wind Energy and its paid promotional entities including the Iowa Environmental Council among many others.

## **Part – 6: Adverse Health Effects**

This aspect of IWTs has been the focus of this entire review. Part 6 is quite lengthy with many studies being reviewed or summarized; there are many details that are worth reading. The first part reviewed Dr. Robert Thorne's 2012 study (Australian) as well as some of the concepts from his "textbook-equivalent" (2014). It is important to recognize that annoyance (all forms) are adverse health effects. Adverse health effects can "arise from extreme psychological stress from environmental noise, particularly low frequency noise with symptoms of sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic attack episodes associated with such sensations when awake or asleep. More serious harm to health occurs when, related to the presence of IWT noise, residents suffer recurring sleep disturbance, anxiety and stress. Thorne's review suggested that 5-10% of the individuals in the vicinity of a large wind farm will experience serious harm to their health. That AHE prevalence was generated on his study of residents living at an average distance of 1400 meters which is three times farther than the distance proposed by Madison County supervisor, Phil Clifton. Within Thorne's study, the observed markers for serious health effects were noted with wind farm noise: 1) 32 dBA Leq or more OUTSIDE the resident and 2) if it is perceived or heard in any form inside the house. He defined "serious harm" if 1) the resident is obliged to remove themselves from the exposure in order to mitigate the harm 2) if three serious AHEs are present as listed as a state of constant anxiety, anger and helplessness and having abnormal "scores" from validated sleep and mental health surveys.

Many pieces of information are included, briefly:

Dr. Daniel Shepherd described Wind Energy's actions to deprive a resident of his health also extend to his well-being, quality of life and amenity.

Dr. Hanning commented on sleep disturbance (which I too have seen in patients presenting with heart arrhythmias and obstructive sleep apnea), that "inadequate sleep has been associated not just with fatigue, sleepiness and cognitive impairment but also with an increased risk of obesity, impaired glucose tolerance, high blood pressure, heart disease, and depression". Sleepy people have at least a doubling of their risk of traffic accident related mortality.

Dr. Michael Nissenbaum declared a "high probability" of significant AHEs for residents living within 1100 meters and a significant risk of AHEs in a significant subset of people living out to 2000 meters from an IWT. (Mr. Clifton has proposed 500-meter separation from IWT to residence).

Dr. C.V. Phillips in testimony before the Wisconsin Public Services Commission summarized that there is ample scientific evidence to conclude that wind turbines cause serious health problems for some people living nearby. In addition, he commented on the observation of people vacating their home being an "exposure-disease" combination. Furthermore, 'the (Wind Energy) reports that claim that there is no evidence of adverse health effects are based on a very simplistic understanding of epidemiology and self-serving definitions of what does not count as evidence. Though those reports probably seem convincing (on first appearances), they do not represent proper scientific reasoning, and in some cases the conclusions of those reports do not even match their own analysis".

McBride, et al (2014) found that some people living near wind farms had a lower quality of life than others due to increased levels of stress and poorer sleep. It also became apparent that the objective manifestations of health effects associated with noise-related annoyance may emerge after some years of exposure.

Schmidt (2014) produced a particularly "interesting" characterization about sound levels: "....at present, it seems reasonable to conclude that noise from wind turbines increases the risk of annoyance and disturbed sleep in exposed subjects in a dose-response relationship. There seems to be a tolerable limit of around Leq of 35 dBA. MY COMMENT: Why is the resident required to "tolerate" a detectable noise level? Toleration implies ongoing annoyance which, in itself, an AHE. The audible noise threshold (known for at least 20 years) is 30dBA as a Lmax, i.e. "shall not exceed" discrete sound limit. 32 dBA Lmax and above disturbs sleep which causes adverse health effects.

The remainder of the section reviews annoyance, low frequency noise related AHEs and infrasound recognition and AHEs. The latter two are felt by some investigators to be even more annoying than audible sound and potentially more concerning for serious adverse health effects.

#### **Cardiovascular Disease:**

**(Some of this was reviewed in the prior section)**

The World Health Organization in 2018 produced a document reviewing impacts from environmental sources. These focused-on road traffic, rail and air traffic and included wind turbine and leisure noise sources. The WHO data review boards measured 3 critical health outcomes of cardiovascular disease, effects on sleep and annoyance. Cardiovascular disease could lead to more severe disease and/or mortality and both sleep and annoyance may be in the causal pathway to cardiovascular disease. The data directly from available IWT exposure studies is considered "conditional" with available studies not being of sufficient "power" to currently consider the evidence to be "strong" enough to include IWT noise. NONE of the available data suggested otherwise. Notable is that wind turbine noise has been described as having a character that makes it far more annoying and stressful than other sources of noise at the same A-weighted level, including traffic and industrial noise. Additionally, Thorne, has pointed out that human perception of noise is based primarily on sound character rather than sound level, and that wind turbines are unique sound sources that exhibit special audible and inaudible modulated and tonal characteristics.

Particularly noteworthy are the WHO recommendations to policy-makers to reduce exposure from wind turbines in the population exposed to levels of 45 dB Lden. Other forms of environmental noise which also had recommended noise levels were:

Aircraft: 45 dB Lden, 40 dB Lnight

Railway: 54 dB Lden, 44 dB Lnight

Road Traffic: 53 dB Lden, 45 dB Lnight

Industrial Wind Turbines: 45 dB Lden - nothing specified for night given inadequate data to allow a recommendation. The review data committee conditionally recommended that policy-makers implement suitable measure to reduce exposure from wind turbines in the population exposed to levels above the guideline values.

Given the current strength of available data, those sound level noise limits above are state in L"den" which means day, evening and night are set to hopefully avoid significant cardiovascular disease caused by environmental noise. Note that IWT level is equal to the aircraft level and much lower than railway or traffic noise. Lden is a "European 24-hour metric" with 5 and 10 dBA penalties for noise levels for evening and night respectively. A Lden of 45 dBA is approximately 38 dBA Leq that would imply (through normal calculation of Lden to Lnight - not specifically stated) a Lnight of 35 dBA Leq.

The reported guidelines were published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience, as a large body of the evidence underpinning the recommendations was derived not only for European noise effect studies but also from research in other parts of the world - mainly America, Asia and Australia.

Under Part - 2 Sleep, I reviewed two more studies (that were published in 2019 - after the 2018 WHO



report) that correlated sleep duration with cardiovascular disease presentation and with the development of asymptomatic cardiovascular disease (ultrasound-measured atherosclerotic vascular disease burden). These were large studies that linked sleep duration with disease endpoints without consideration of mention of sound levels, specific noise sources. Both of these studies initially appeared in "Cardiology Today" in February 2019 and were explained under the title of "Sleep: the new frontier in cardiovascular prevention". Both studies have been published in prominent cardiovascular journals.

We know (as described in Part-2), that sleep is a required body function to restore and maintain normal health. It is much more complex than a set minimum duration but is composed of a complex set of stages (characterized as "architecture") through which sleep progresses to achieve specific organized neural activity (brain waves) during which memories are laid down, and metabolic by-products are removed - all in preparation for the "the next day". Stress (also termed allostatic load and caused by a variety of factors - sleep disturbance, annoyance - at various levels/sources) may interfere with "whole-body" health through chronic autonomic activation in mostly the "fight-or flight" (i.e. sympathetic) limb of an otherwise balanced and freely "oscillating" shift of the sympathetic and parasympathetic limbs.

Sleep duration in the studies above WAS associated with measured objective adverse cardiovascular endpoints. Obstructive sleep apnea has been associated with increased cardiovascular disease endpoints as has inhalation of very small particle sizes, post-traumatic stress disorders and an increasingly number of "chronic disease states". As described in the May, 2014 Journal of the American College of Cardiology, "Dysregulation of this system (autonomic) due to aging, acute and chronic stress, organic and idiopathic and other causes contribute to cardiovascular pathology, including hypertension, ischemic heart disease, arrhythmias and congestive heart failure and often contributes to fatal outcomes".

For the purpose of providing evidence of an existing framework through which autonomic dysregulation operate, I briefly described the mechanism involving the renin angiotensin aldosterone system (RAAS) and included a description of chronic stress and Endothelin-1 which is a vasoconstrictor agent that is integral to stress-triggered disease states. I also reviewed the complex relationship of obstructive sleep apnea (and associated chronic higher sympathetic tone) and the development of cardiovascular diseases.

## **Part - 7    Additional Topics**

The Nocebo Effect, in my mind may be Wind Energy's most original piece of "science", however has no relevance to chronic annoyance associated with IWT exposure. The WHO has completely rejected any relevance of the Nocebo effect. The Wind Farm Noise textbook pronounced Wind Energy's literature "claiming to prove that all adverse health effects are a result of a nocebo effect" is based on suspect data. A fair and thorough critique of the nocebo effect also appeared in the Punch and James review article. They reviewed the Chapman, Crichton and Taylor studies and pointed out multiple shortcoming and improbable conclusions. They concluded that "we believe that while psychological expectations conceivably can influence perceptions of the effects of wind turbine noise on health status,

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no scientific studies have yet convincingly shown that psychological forces are the major driver of such perceptions. Punch and James believe those drivers are the physical stimuli themselves and the internal physiological reactions they induce.

There exists a range of noise sensitivities across a population of people; there is NOT a precise and specific noise threshold for sound sensing for all people. People respond differently to different sound types and sound levels. This simple fact of normal human "variance of phenotype expression" (...everyone is a little different) is almost always missed or is unknown by most people. At the series of three Supervisor "town hall" meetings requesting public opinion about IWTs, many "pro-wind" individuals (who lived in the Macksburg Wind Farm) provided oral testimony saying that there was no danger from wind turbines as they were unaware of any problems they had noticed and that they could work all day and were not bothered by turbine sound. They also commonly mentioned that they "had no trouble sleeping". Such testimonies represent the "lucky ones" (....so far) as well as well-known auditory responses involving background noise levels, etc. Minor degrees of annoyance could include up to 30% of individuals where IWT siting is within 500 meters of a house. Such interpersonal differences do not reflect that IWT noise recognition is more emotional-based or subjective or easily ignored or in any way "contrived".

"Human rights and social justice" reflect upon and reviews the loss of respect that we have for our neighbors that are "forced" to endure chronic IWT noise and frequently become victims of its annoyance and adverse health effects. A very recent article (Krogh, et. al., published June 28th, 2020) on why residents evacuate their homes provides intimate connection to their perceptions of imposed injustice. One resident asks "why is it the responsibility of the potential sufferer to prove the proposed adverse health effects rather than the initiator of the risk to adequately demonstrate the absence of health consequences prior to initiating the risk? Affected residents rightly ask why they are considered "expendable". Current turbine approval practices violate the "precautionary principle" that would require that a particular industrial activity not be undertaken unless there is no doubt that such an activity will not harm any people. Again, my recurrent statement to Wind Energy: Industrial Wind Turbines have never been proven to be safe. No response - which is their response when they have nothing to counter that statement (and they hope the question eventually just "goes away").

There is a review of vulnerable populations in a very complete review of acoustic considerations for schools and other learning environments. The WHO and ANSI (American National Standards Institute) talk about the concerns of a noisy classroom, noting that a signal to noise ratio of +15 dB (i.e. speech signal is 15 dB louder than the background noise) is needed to optimize classroom communication. Since 50 dBA is the sound pressure level of normal speech, room noise levels of 35 dBA or more interferes with the intelligibility of speech in smaller rooms. Mr. Clifton and Price believed that school room sound levels in West Des Moines were possibly 45 dBA. Of particular relevance is that "learning" goes on at home as well as in schools. In addition, high quality, restorative sleep with more sleep time needed by developing children - a critical part of health brain development - is needed when children return home. Such "brain development" may be affected by neuro-cognitive impairment from inadequate sleep.

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Of substantial importance to the "healthy growth" of Earlham or any other town will be "room" to grow at outward from the current town margins. Please see my suggestion in that section.

Cardiovascular disease remains the leading cause of death in the United States - unfortunately that trend is increasing over recent years. The decrements in cardiovascular outcomes have been worse for people living in rural counties. Madison County is considered a rural county without an urban core. There is now at least a 20% disparity with rural counties having a worse death rate as measured by "excess death rate" per 100,000. Data from the 2017 CDC showed a 40% higher prevalence of heart disease among rural residents - a gap that has grown over the past decade. Rural areas have higher rates of uncontrolled traditional cardiovascular risk factors compared with urban areas. There are other listed "sobering" facts. Placing annoying/sleep-depriving industrial wind turbines in rural populations seems particularly cruel and insensitive as the additional negative health (physical and mental) consequences of IWTs on rural populations will likely be much worse in that population with already worse existing cardiovascular disease.

I reviewed some thoughts about electricity costs, decommissioning costs, blade disposal, minimal recycling potential "realities", shrinking turbine warranty periods, and the usual practice of placing IWTs in close proximity to residents to essentially guarantee "resident outrage and annoyance". Current practices by MAE reliably invite litigation which should be seen as a "replacement of science and a failure of leadership".

Blade throw has been mentioned at most meetings concerning IWT placements and ordinances. A study from a university engineering department in conjunction with a Wind Energy consultant at a national IWT testing center made the follow conclusions and recommendations: setback from IWT to property line should be 2 times the overall turbine height and from IWT to residence should be 3.5 times the height. Mr. Clifton suggested 1.1- and 3.0-times height respectively without providing any source documentation for that empiric distance except to "try to get more turbines inside a section - his words".

## **Part – 8: Peer Review**

I first describe the purpose and the execution of research undertaken (mostly in medical situations) of new products, new dosing or combinations of existing treatments, comparison of new treatment regimens to existing "current standard of care" treatment for human illness such as cancer and heart disease and a host of other human conditions. It also covers new devices - implantable insulin pumps, pacemakers, defibrillators, leads that used with such implantable devices, neuro-stimulators and many other "gadgets" in which safety is paramount and showing that the medications, treatment, device is effective. As commented, there are multiple layers of oversight from local to regional to national levels. Training of investigators and co-investigators is needed. Of particular importance is that close monitoring of "adverse events" is done and reported to the study sponsor and the local IRB (Investigative Review Board). The latter entity is charged with the protection of study subjects,

acquiring informed consent from participating subjects, monitoring the occurrence and types of adverse events and making sure that death, heart attacks, bad infections and on and on.... are recognized, treated and changes to the research are made if necessary and close follow-up is maintained. The IRB has the right to "shut-down" an ongoing research study in which unexplained, or excessive amounts of serious events among other endpoints, occur.

An initial study examining potential adverse events associated with IWTs never occurred or I am sure I would've heard about it - particularly after describing it in an article I wrote for the Madisonian newspaper. I am not suggesting (because I do not know for sure), that "formal" IRB oversight for a trial designed to confirm safety should have been done but the sheer amount of AHEs and the controversy and unsubstantiated claims made by Wind Energy/turbine manufacturers does demand a complete and transparent study examining health consequences. Given the amount of unreported events and uninvestigated problems associated with IWT exposure, unknown short- term vs long-term consequences of exposure and the complete (best I can tell) lack of detailed medical investigations of adverse health events by trained medical personnel in conjunction with biomedical engineers with ongoing dramatically increasing size and noise emissions outputs of new IWT models without initial and interval reassessment of human impact is (in my opinion), unethical. This is even a more dramatic omission given the rapid growth of our understanding of sleep and its importance and the environmental noise levels that trigger sleep disruption being substantially exceeded by "current accepted" practices of close siting of IWT to places of residence. Of particular concern which is essentially ignored, is the possibility of vibroacoustic disease in animals and humans occurring with resonance energy transference to solid organs. Visual complaints are not infrequent in residents in recently activated wind farms. Reports of blindness in ducks, donkeys, horses and occurrences of unexpected sudden death in farm animals, dogs and other pets has been reported by residents. Post-mortem examination on animals have found "enlarged organs". To my knowledge this has not been evaluated in formal studies. It certainly has not been reported by the manufacturer of IWTs nor energy contractors. The occurrence of these observations is not disclosed to easement participants. As I explained to our county supervisors, "I am not aware that people and their live animals are considered 'expendable' when forced to endure unwanted and uninvestigated powerful low-frequency noises". Reading about infrasonic acoustical weapons research (where available) in the U.S. and the former Soviet Union, raises concern - particularly for more chronic (long-term) exposure at "just-less than weapons grade power levels". Remember, as the IWTs keep getting larger and more powerful, there is a progressive relative increase in levels of ILFN emissions they generate.

There is also a review of scientific processes to determine causality by properties of causal relationship. Sir Bradford Hill's work was summarized. The value of adverse health reports as related by Carl V. Phillips was reviewed. Outside critiques are included of one of Wind Energy's promoted studies that honor their view: the AWEA/CANWEA Report into Turbine Sound and Health.

## **Part – 9: A view toward "The Dark Side"**

In this section, I listed several visions through the cracks in Wind Energy's veneer of corporate sainthood and righteousness. These primarily focus on the Danish company Vestas which is the leading

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manufacturers of industrial wind turbines. They are worth reading and placing into the bigger context of "why they say what they say and do what they do". I provide these as "past actions" that have happened. I do not cherish these "uncloaking's" but, personally, they, at least, helped me understand the more important "bigger picture"... perhaps more important than "arguing decibels". Please see my disclaimers.

An exceptional "profile in courage" was a speech to Vestas Corporate by a Danish physician who (in my opinion) laid out the facts and asked Vestas to do the right thing. Powerful...

#### **Part – 10: Carbon.... What to do.**

Here I humbly present my concerns about global warming and review some of the concepts that keep me up at night - loss of biodiversity and loss of a lot of happiness.

I list what I believe are better choices for energy management in our future. I vaguely refer to "nuclear energy" as I have listened to others far brighter than I who see this as more sustainable, cleaner and, when deployed and monitored closely, much safer. What is clear and has been for far too long, is that our current ways of utilizing planet resources are simply not sustainable. I strongly believe in the environmental promise of regenerative agriculture which works to sequester atmospheric carbon- particularly in Iowa. Although it has been a recognized way to farm for more than 150 years, (we) have switched to an agrochemical style farming practice (this opens up a huge area of complexity). Regenerative farming restores the CRITICAL connection between growing plants and organic soil rejuvenating processes. Others have seen this farming practice and jumped in to find extraordinary rewards. Observed phenomenal benefits of increased soil fertility through regenerated organic content of our soils are observed returning the soil back toward the complexity of pre-settlement soil architecture. Such increasingly restored soils facilitate much less carbon-producing farming practices, greater ability to retain water with better avoidance of soil erosion - the latter problem being another new reality of "Man-induced" global warming. It is truly a win-win option that we should acknowledge and pursue NOW – in Iowa and at a world-wide scale.

#### **Part – 11: Applied Regulation of Noise**

In this section, there is a focus on achieving an optimal residence sound level for achieving restorative sleep. Consideration of outside-to-inside audible sound attenuation are discussed in line with WHO recommendations. Difference of Leq vs Lmax are described and why, to protect sleep, the Lmax sound limits are much preferred. The math of decibels is described illustrating why 45 Leq as seen with a 2 MW IWT at 1500 feet from a residence will NOT achieve the recommended level of 30-32 dBA Lmax.... instead setbacks to be in compliance with those nighttime sound limit levels will require separations of 2 km or about 1.25 miles WITHOUT IWT clumping or in-line siting. Anything shorter creates significant annoyance and leads to complaints, lawsuits, home evacuations and other severe adverse health effects.

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**Part – 12: Recommendations**

In this section I included scenarios and considerations that protect the residence from annoyance and most other forms of adverse health effects. I do not believe a "compromise to permit co-existing industrial energy production that is associated with noise effects that harm residents are acceptable. The energy developer must be willing to compensate or "buy-out" the resident if at a pre-wind farm placement appraisal price. Setbacks distances are not the primary metric of IWT siting - target receptor sound levels are THE PRIMARY determinant. Setback distances from property are important as well and should be 2 times the total height of the turbine. It is unfortunate that IWTs currently deployed have such serious health consequences at previous utilized distances of 1500 feet. Indeed 3600 feet is the shortest distance listed in the Punch and James review article and that depends on a calculated target sound level likely not possible with such large IWTs. Realistically, 2 MW IWTs will have to be >1.25 miles to achieve safe home experienced emission levels. At that distance, annoyance will be minimal and serious AHEs and litigation will be likely non-existent. Utilizing unapproved ETSU-R-97 guidelines that employ "pseudo-science" considerations for nighttime sound levels in rural residential environments with background noise levels of about 25 dBA is absurd and presents "willful abuse and unethical actions" of an energy contractor. I would like to see a maximal permissible/worst case scenario resident sound level of Lmax of 40 dBA or a Leq of 30 dBA. These are concordant with textbook recommendations and countries who have responsibly responded to the demands of health safety and property rights. In addition, separate Lmax regulation of ILFN emission using C-weighted values is strongly suggested.

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**Part – 15: Conclusions**

Avoiding "Adverse Health Effects" is the focus of health care. "Doctoring" in early America (simplistically) revolved around fixing bones, sewing up lacerations and delivering babies. As our understanding of disease processes and normal and diseased human physiology has exploded in recent decades, we now see applications of endless technologies to address the physical and mental health needs of our suffering fellow human beings. Recognizing and attempting to encompass all "contributors to disease" in our desire to reach "optimal health" has broadened our focus from individual disease expression to include societal factors that can trigger and exacerbate disease and limit the high quality of life we all seek. Indeed, the Affordable Care Act (whether you like it or not) as well as competitive private health plans and Medicare services emphasize "prevention and wellness".

As stated, the WHO defines health as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity". This model of health considers the physiological, psychological and social factors in health and illness, and interactions between those factors. The WHO definition links health explicitly with wellbeing and conceptualizes health as a human right requiring physical and social resources to achieve and maintain. "Wellbeing" refers to a positive rather than neutral state, framing health as a positive aspiration. Health is considered as "a resource for everyday life, not the object of living". Health is a means to living well, which highlights the link between health and participation in society.

Mental health and physical health are inextricably linked; with mental health influencing physical health and vice versa. Stress responses are known to affect physiological processes regulated by the autonomic nervous system including cardiovascular, respiratory, digestive, repair and defense functions. While it is clear that physical ill-health can be accompanied by mental health problems such as anxiety and depression, the resulting psychological state may in turn impede the recovery or stabilization of medical conditions, thus producing a vicious circle in which wellbeing is difficult to attain. All this is said to emphasize that annoyance - at almost any level - can contribute to adverse health effects. This is particularly relevant when the source of annoyance is not wanted and cannot be eliminated and leaving one's home is the only remedy.

It is important to demonstrate past recognition of "annoyance as an adverse health effect". Please see the following citations:

The 2009 WHO Night Noise Guidelines for Europe created a flow diagram of (environmental) noise exposure with high sound levels directly activating "stress indicators" including the sympathetic limb of the autonomic nervous system. Moderate noise levels were pictured to follow an indirect pathway noting sound disturbances of activities, sleep, communication producing cognitive and emotional response - described as "annoyance".

The Council of Canadian Academies (4/9/15) described their review of supportive evidence for "annoyance" to be sufficient when referring to contributions to adverse health effects.

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Data from the LARES study (2006) "confirmed, on an epidemiological level, an increased health risk from chronic noise annoyance. (further) The results of the LARES study in relation to severe annoyance by neighborhood noise demonstrate that neighborhood noise must be classified as a serious health endangerment for adults".

Pedersen and Persson Way in "Wind Turbine Noise, Annoyance and Self-reported Health and Well Being in Different Living Environments" (2007) stated: "Annoyance is an adverse health effect".

The WHO Training Package states that adverse effects from noise exposure can include direct ear damage, indirect adverse effects (physiological and psychological effects) and impaired cognition.... Cognitive effects can include reading, concentration, memory and attention issues. Chronic noise exposure impairs cognitive function (reading comprehension and long-term memory) and that dose-response relationships are supported by both laboratory and field studies and that "over 20 studies have reported that noise adversely effects children's academic performance".

Bakker, et al, in "Impact of wind turbine sound on annoyance, self-reported sleep disturbance and psychological distress" (2012) noted: "A dose-response relationship was found between emission levels of wind turbine sound and self-reported noise annoyance. Sound exposure was also related to sleep disturbance and psychological distress among those who reported that they could hear the sound, however not "directly" but with noise annoyance acting as a mediator. Respondents living in areas with other background sounds were less affected than respondents in quiet areas".

In 1991, Suter on "Noise and its Effects - Administrative Conference of the United States" stated: "noise has a significant impact on the quality of life, and in that sense, it is a health problem in accordance with the World Health Organization's definition of health....along those lines, a 1971 WHO working group stated: "Noise must be recognized as a major threat to human wellbeing....annoyance can connote more than a slight irritations; it can mean a significant degradation in the quality of life. .... this represents a degradation of health..."

Michaud, et al "Noise Annoyance in Canada", Michaud is a staff member of Health Canada, Referring to the WHO definition of health, "under this broad definition, noise-induced annoyance is an adverse health effect".

(2010) Heath Canada document: "Health Canada considers the following noise-induced endpoints as health effects: noise-induced hearing loss, sleep disturbance, interference with speech comprehension, complaints and change in percent highly annoyed"

Jeffery, Krogh, Horner (2013) "Adverse health effects of industrial wind turbines", Canadian Family Physician, "noise-induced annoyance is acknowledged to be an adverse health effect. Chronic severe noise annoyance should be classified as a serious health risk".

General Purpose Standing Committee.... (2009, Australia): "...reputable research has shown that noise annoyance is an adverse health effect that can result from wind farms, as it can result in effects such as negative emotions and sleep disturbance.



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Of great importance are comments from Wind Energy's principle thought-leader acoustician, G. H. Leventhall:

Leventhall (2009) attributes these reported IWT symptoms as effects of 'annoyance by noise' stating, "I am happy to accept these symptoms, as they have been known to me for many years as the **symptoms of extreme psychological stress** from environmental noise, particularly low frequency noise". The effects of low-frequency noise-induced annoyance and stress from various sources have been researched".

Levanthall (2004), "Regulatory authorities must accept that annoyance by low frequency noise presents a real problem.... " and that "The claim that their 'lives have been ruined' by the noise is not an exaggeration..."

From Wind Farm Noise (textbook):

There is a considerable amount of anecdotal evidence and published research that suggests that wind farm noise does seriously and adversely affect a small but significant proportion of the population. Nevertheless, many acoustic, social science and medical **professionals ignore this evidence by defining 'scientific evidence' in a very narrow way and then stating that there is no 'scientific evidence' available that proves beyond doubt that wind farm noise can harm anyone.**

**(Writer comment: This is exactly the wording and precisely the tact that Wind Energy uses to dispute the magnitude of contrary data that I have summarized and presented here).**

As pointed out by May and McMurtry (2015), there seems to be a tendency in the medical research discipline to interpret the lack of rigorous evidence of a causation link as proof that the link does not exist.

(Writer's comment: Previously, in part - 8 "Peer Review", I described the nine elements that Sir Austin Bradford Hill felt were critical in establishing causation are relevant and adequate to declare (in assessment of the data) that IWTs cause adverse health effects. Sir Hill noted that "all scientific work is incomplete - whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. But that does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time. In other words, if it quacks like a duck, looks like duck and flies like a duck, (and 6 other features) ... then it is reasonable and appropriate to believe it is a duck).

There have been many hundreds of case studies that demonstrate that the health of a significant percentage of people has been affected by wind turbines. **Whether or not these adverse effects are directly caused by wind turbine noise or are indirectly caused by such things as sleep disturbance as a result of a nearby wind farm is a moot point, as either case results in the same conclusion: that is, wind turbines result in some**

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**people living in their vicinity suffering adverse health effects.**

Even further to support that wind turbines cause adverse health effects, it is remarkable (in light of the strong wording of implausibility Wind Energy carefully uses each time when proclaiming "non-causality") is that the literature that Wind Energy offers to support that phraseology, state that "IWT noise produces annoyance". Annoyance as a concept is well-established and used by both sides of the argument. The World Health Organization (and MANY other researchers) define annoyance as causing adverse health effects. Indeed, Wind Energy's "top acoustician", Dr. Leventhall, explains symptoms created by wind turbine noise exposure as consistent with his experience with low frequency noise effects he himself has experienced. Dr. Leventhall did some of the earliest evaluations of low frequency sound found in the evaluation of "noise-induced sick building syndrome". He helped to conduct the controlled tests needed to separate out the characteristics of HVAC sound associated with the reported symptoms and poor work performance (range of symptoms of HVAC were quite similar to later symptoms associated with low frequency wind turbine noise). These symptoms were linked to modulated low-frequency (and infrasound) HVAC noise.

Earlier, in 1982, Leventhall and Vasudevan published "A study of Annoyance Due to Low Frequency Noise in the Home". The abstract described annoyance leading to health problems in some cases. ... low frequencies were capable of causing annoyance, especially when the noise fluctuated in level (Writer comment: "was modulated"). In his introduction he also commented "when the noise nuisance also involves low frequency noise, much evidence exists to suggest that the annoyance reaction to the low frequency noise is greater than that implied by the (measured) estimates of loudness of the noise. The A weighting scale... takes little account of the low frequency sound energy. This practice in industrial noise regulation often encourages machinery manufacturers to concentrate almost entirely on attenuating energy in the middle and high frequency ranges. As a consequence, modern plan and machinery - increasing in size all the time - may be making a growing contribution to the sound energy in the low frequency range. The noise could become subjectively louder although the dBA level is reduced". (These comments by Dr. Leventhall almost exactly express the current observations and concerns of industrial wind turbine noise. Again, Leventhall was a pioneer in our understanding of infra- and low-frequency environmental noise which then was "mirrored" by wind turbine noise. Somewhere in the mid- 2000s decade he became aligned with Wind Energy- essentially becoming their acoustician scientist - and his concordance of opinion (with other peer acousticians) that IWT noise cause adverse health impacts essentially reversed without explanation).

Dr. Malcom Swinback, during his 2015 testimony before the Select Committee on wind Turbines in March, 2015, added his observation about health effects associated with wind turbine infrasound. "one of the reasons for confusion in the reporting of adverse health effects from wind turbines lies in the fact that permitted IWT sound levels in the USA **are generally significantly higher** than those in other countries. Whereas many countries now seek setbacks of typically 2 km, in the USA, setback of 300 - 400 meters are not uncommon, with corresponding permitted sound levels of 45-50 dBA or higher. Consequently, there are considerably more complaints from affected residents, compared to other countries with more cautious standards. Worldwide discussion and assessment of such problems often

does not make this distinction clear, with the result that there can be significant confusion as to which problems arise from **these VERY CLOSE SETBACKS, and those which can still prevail at larger setbacks.**

(Continuing from the "Wind Farm Noise" text): "It seems that the only type of scientific evidence that would be generally acceptable to those who do not believe that there are any adverse health effects results from wind farms, would be longitudinal epidemiological study of thousands of people with confounding factors removed, which is clearly an impossible task.... The situation is very similar to the debate on anthropogenic global warming. This too has not been proven beyond any reasonable doubt, but there is plenty of evidence that global warming is occurring and that it is a result of the activities of man. However, there are always those, who for whatever reason, will deny the patently obvious and continue to do so regardless of any evidence with which they are confronted".

In the "Wind Farm Noise" textbook, their conclusions continue...

**It is time to stop debating whether or not a problem exists.** It is well known that wind farm noise does result in sleep disturbance and adverse health effects for some people and the time has come to decide what to do about it. However, further research is needed to determine whether the problem is inaudible infrasound (writer's comment: or perceivable infrasound - particularly as infrasound noise levels rise as IWT power generating capacity increase) or low-level, audible low-frequency noise.

(Writer comment: the textbook continued with reminding us of a "normal" (associated with a bell-shaped response curve) distribution of hearing sensitivities which permits 2.5% of the population to have hearing sensitivities up to 12 dB lower than published sound "limits" and that some people have become "sensitized" over time to wind turbine infrasound. Low-frequency noise rather than infrasound may generate adverse health effects through a stress response as a result of the audible noise being annoying or depriving sensitive people of sleep. The low-frequency noise from wind farms is particularly prominent in rural residences where the ambient noise level is low - especially at night).

The Wind Farm Noise textbook continued: "Affected people find wind farm noise to be very annoying and, as time goes on, they become more and more sensitized to it, (Writer comment: rather than habituated or that their "negative attitude softens or accepts" as Wind Energy may suggest), so they become more stressed and also suffer from insomnia and /or sleep disruption. Whether the problem is infrasound or low-frequency noise is not the most important issue. **The fact remains that some people are so affected by wind farm noise that their health suffers and some are forced to leave their home in order to achieve an acceptable quality of life.** Thus, it is important to begin work on new noise guidelines for new wind farm developments based on maximum acceptable levels of A-weighted noise as well as acceptable levels of low frequency noise. **Existing allowable levels (even the lowest of 35 dBA) are too high** for a significant proportion of the population who live in quiet rural area: the levels of 40 or 45 dBA allowed in some jurisdictions are well over what would be considered acceptable by most people. **In addition, all jurisdictions should determine what would be a fair offer of compensation for those who have suffered ill effects, which would at a minimum include the offer to purchase their residence at the price it would have realized prior to construction of the wind farm.**

An almost identical set of concluding responses are included in the Punch and James (2016) article: Wind Turbine Noise and Human Health in their response to Wind Energy's "blanket statement that there is no evidence in the literature to support a causative link between wind turbine noise and adverse health effects. The authors responded to this statement which is cited as factual by wind industry advocates in the literature and in legal proceedings. (In stark contrast) ... "there is an abundant literature, much of its peer-reviewed and authored by highly reputable researchers, indicating that audible and inaudible noise emitted by IWTs adversely impact the health and well-being of substantial numbers of people who are regularly exposed to wind turbines. It is clear that the literature review and papers claiming no AHEs **fail** to include important studies, international standards, guidance from the WHO, and research conducted on wind turbine noise and other sources of infra- and low-frequency sound. Whether this is through oversight or calculation, only reports that cite scientifically credible references should be considered legitimate sources of information. Our review has shown that it is unacceptable simply to state that the literature contains little or no evidence of a causal link between wind turbine noise and adverse health effects. At a minimum, those effects have been shown to be regularly correlated to living in proximity to IWTs, and there is sufficient evidence that those effects are highly associated with objective measurements of audible noise and infrasound".

The extensive Punch and James, 72-page article that included 180 references, finished with a needed "goal" of refocusing as described below:

"Based on all the evidence presented, our fundamental view is that the controversy surrounding adverse health effects should not be polarized into two groups consisting of either 'pro-wind' or 'anti-wind' factions, but rather one in which there is room for a third, 'pro-health' perspective. Essentially, the pro-wind view is that IWTs should be installed wherever feasible, that definitive scientific research is lacking to indicate that turbines cause AHEs and that if you can't hear it, you can't feel it. The anti-wind view is that IWTs should not be installed anywhere because wind is not an economically viable source of renewable energy, that all government subsidies and development efforts should end and that what we can't hear can hurt us. A pro-health view is that there is enough anecdotal and scientific evidence to indicate that ILFN from IWTs cause annoyance, sleep disturbance, stress and a variety of other AHEs to warrant siting the turbines at distances sufficient to avoid such harmful effects, which, without proper siting, occur in a substantial percentage of the population. That view holds that what we can't hear can hurt some of us and that the precautionary principle must be followed in siting IWTs if such health risks are to be avoided. Industrial-scale wind turbines should not be located near people's homes, educational and recreational facilities and workplaces. It is our belief that the bulk of the available evidence justifies a pro-health perspective. It is unacceptable to consider people living near wind turbines as acceptable collateral damage while this debate continues."

I too, have pursued an entire life's career to "Pro-Health" goals - in the treatment of my patients as well as my neighbors and the community that I live in. Believing that IWTs placed "in harmful proximity to places where people live and work" to represent the answer to our world's energy production is like a discovering a bottle on the beach and expecting to find a genie inside that will provide answers to our wishes. When you look at the whole picture of wind-sourced energy to be clean and renewable and

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provide a clear pathway to environmentally-safe energy production, you realize that there is a misdirected faith in its supposed benefits. Instead we have to look toward other answers - rapid escalation of regenerative agricultural practices to sequester (ongoing) massive quantities of CO2 back into the soil, safe nuclear energy production, tolerable placement and recyclable photovoltaic electric production, much higher standards of efficiencies of heating and (particularly) cooling and many others and always...living "within our means". Afterall, we are sharing this planet with more than 3 times as many people than is reasonably sustainable given the finite resources of our natural world.

Mathias Basner, MD, PhD, attempted to frame the latest information about potential physical harm with environmental noise in a 2019 medical journal editorial. Dr. Basner is an Associate Professor of Sleep and Chronobiology in Psychiatry. He is the President of the International Commission of Biological Effects of Noise who personally reviewed and helped to summarize the data for the Oct, 2018 World Health Organization Environmental Noise Report. In the editorial, he acknowledged the problem of smaller populations in currently available studies which make statistical powering of conclusions difficult. He has stressed that NONE of the wind noise guidelines data from the 2018 WHO raised found an "absence of risk". He finished his comments with **"the fact that more studies are needed should NOT lead us to postpone the urgently needed protection of the population from noise. The knowledge we have acquired so far IS SUFFICIENT to take preventive actions and substantiate them with respective legal noise regulation."**

Bullets:

With the possibility of adverse health effects and industrial wind turbines it comes down to:

- 1) We have to accept that operating IWTs do produce noise that is harmful to an important percentage of those nearby; they are not harmless "pinwheels spinning in the distance".
- 2) Industrial Wind Turbines have never been shown to be safe for human health with respect to developing adverse health effects - particularly with long-term exposure to turbine noise. Accepting Wind Energy's proclamation that there is no credible evidence of a causal relationship between IWT noise and adverse health effects is to deny the existence of an enormous amount of information that link adverse health effects to exposure to IWT noise.
- 3) There is a range of human sensitivity to hearing or perceiving wind turbine noise. This means that some people will have serious adverse health effects while some may experience none. This variance in experienced health effects, after review of the bulk of literature (per Punch, James), are the physical stimuli themselves and the physiological reaction they induce.
- 4) Sleep disturbance is the most frequent of the most serious adverse health effects. It is not only related to excessive audible noise level but also to amplitude modulation in lower frequencies and audible and perceivable portions of the infrasound noise spectrum. Significant disturbed sleep will lead to mild to severe annoyance suffering and may promote serious cardiovascular disease.

5) We need to recognize the heightened susceptibility of adverse health effects in vulnerable populations that live within the range of wind turbine noise emissions. Providing quiet home and learning environments for children is essential for normal brain development.

6) As recommended by a wide range of supportive literature, World Health data and recommendations, textbooks that have very thoroughly researched all aspects of IWTs including health effects, greater scientific understanding of the importance of restorative sleep and strong confirmation of a need for a precautionary approach to avoid AHEs and likely serious health outcomes, we need to act NOW to implement protective ordinances for our citizens. Such adequacy of an ordinance is judged by the resultant absence of resident complaints and initiated legal action. To knowingly inflict resident oppression that compromises health is immoral. Continued optional IWT close-siting practices done solely to generate increased financial gains for wind contractors represents a failure of leadership by both parties and intentional disregard of voluminous concordant scientific data.

Editorial

# Noise: What is to be Done?

Mathias Basner

Editorial to accompany the articles:

„Aircraft Noise and the Risk of Stroke—a Systematic Review and Meta-Analysis“

and

„The Cardiovascular Effects of Noise“

In this issue of  
Deutsches Ärzteblatt  
International

Hearing loss is one of the most severe health effects of noise with 1.3 billion affected people worldwide (1). However, health effects of noise go far beyond hearing. The so-called non-auditory effects of noise include annoyance reactions of the exposed population, sleep disturbance, school children's learning impairment, and cardiovascular disease like an increased risk for hypertension and myocardial infarction. (2). According to the World Health Organization (WHO), circa 1.6 Million healthy life years are lost annually due to non-auditory effects of environmental noise in the Western European member states alone (3).

Noise is defined as „unwanted sound“. While the auditory effects are predominantly determined by noise level and exposure time, the circumstances of the noise exposure play a crucial role for the non-auditory noise effects. For example, patrons of a rock concert do not perceive the music as noise despite high sound pressure levels. In contrast, a person living three blocks away from the concert hall who cannot fall asleep because of the music perceives the music as noise despite much lower sound pressure levels. Sound is often perceived as noise if one has little control over it and feels at somebody else's mercy (4).

## Little doubt: Noise is an important risk factor for cardiovascular disease

The number of studies on the health effects of noise has increased considerably over the past few years. Even if high-quality studies are still missing for many noise sources and disease endpoints, there is little doubt among noise effects researchers that noise is an important risk factor for cardiovascular disease. One may thus ask why the prevention of noise-induced health effects does not play a more important role in politics. Several reasons may be responsible.

• We habituate to many things—including noise. However, the habituation is rarely complete, i.e., pathophysiological processes are still at work even if we no longer perceive noise as such. (5). Similar to the genesis of many other diseases, noise effects are also the result of cumulative processes, i.e., health impairment is the result of relevant exposure over long periods of time. Humans are markedly bad at connecting our present behavior with future outcomes. All these are possible reasons for why the strain imposed by suffering from noise does not exceed a critical level in the population, and why only some affected people actively fight those responsible for the noise. Even if

scientific studies constitute an important foundation for political decision processes: considerable pressure from the affected population is often a prerequisite for political change (6).

• The risk increases found in epidemiological studies are often comparatively moderate. Accordingly, in the meta-analysis of Weihs et al. (7) the point estimate for an increased risk for stroke was 1.013 per 10 dB L<sub>DEN</sub> increase in aircraft noise exposure. Due to the large number of relevantly exposed persons even this small risk increase has public health relevance. However, the strength of an association is one of the classical epidemiological criteria for causality. The weaker the association, the greater the concern that unobserved confounders or other systematic biases could account for the observed effect. Accordingly, it is easy for those responsible for the noise emission to dismiss the epidemiologic evidence as insufficient.

• We also have a noise equity problem. Noisy areas are less attractive, less expensive, and therefore attract low-income residents with equally low political influence. This assures that noisy areas stay noisy and quiet areas stay quiet.

• Last and probably most important—noise not only produces victims: Patrons of a rock concert enjoy the music and do not want to miss out. Bikers love their loud exhaust systems. An airport is an important economic factor for a region and generates many jobs. It also brings many amenities for those who live close to it but not under the flight tracks. Thus, for each resident affected by noise another resident in favor of the noise source is quickly identified. This is why noise regulations always have to strike a fair balance (8).

## At what point is loud too loud? Critical role of noise effects research

The critical question is: When is loud too loud, i.e., at what noise exposure level are the basic rights for physical and psychological well-being violated? Noise-effects research plays an important role here. Reviews like the ones on the following pages can help evaluate the results of multiple studies. The review of Hahad et al. (9) shows that, despite some limitations, our knowledge on the cardiovascular health effects of noise has increased substantially since 2007. However, the quality of the studies could often be better. Accordingly, Weihs et al. (7) assessed the quality of the studies contributing to their state-of-the-art meta-analysis as average to low.

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MEDICINE

Comparability of studies urgently needs to be improved

Missing standardization of both exposure and outcome variables complicates systematic reviews and constitutes a general problem in noise-effects research. As Weihofen et al. (7) remark correctly, more high-quality studies are urgently needed that include exposure metrics that go beyond average noise levels. Hopefully, this research need will be reflected in future funding for noise-effects research in Germany.

However, the fact that more studies are needed should not lead us to postpone the urgently needed protection of the population from noise. The knowledge we have acquired so far is sufficient to take preventive actions and substantiate them with the respective legal noise regulations (10).

**Conflict of interest statement**

Dr. Basner received a honorarium from the World Health Organization (WHO) for preparing a literature review on the effects of noise on sleep. He received grants from the Federal Aviation Administration (FAA) to perform studies on the effects of aircraft noise on sleep. Dr. Basner is president of the International Commission on Biological Effects of Noise (ICBEN).

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