

**BEFORE THE PUBLIC UTILITIES COMMISSION  
OF THE STATE OF SOUTH DAKOTA**

**IN THE MATTER OF THE APPLICATION BY DEUEL HARVEST WIND ENERGY LLC  
FOR ENERGY FACILITY PERMITS OF A WIND ENERGY FACILITY AND A  
345-KV TRANSMISSION LINE IN DEUEL COUNTY, SOUTH DAKOTA FOR THE  
DEUEL HARVEST NORTH WIND FARM**

**SD PUC DOCKET EL18-053**

**PRE-FILED SUPPLEMENTAL DIRECT TESTIMONY OF DR. MARK ROBERTS  
ON BEHALF OF DEUEL HARVEST WIND ENERGY LLC**

February 14, 2019

1 **I. INTRODUCTION**

2 **Q. Please state your name, employer, and business address.**

3 A. My name is Dr. Mark Roberts. I am employed by Exponent, Inc. ("Exponent"), and  
4 my office is located at 525 West Monroe Street, Suite 1050, Chicago, Illinois 60661.

6 **Q. Please describe your educational and professional background.**

7 A. I am a Principal Scientist in the Chicago office of Exponent, a scientific research and  
8 consulting company headquartered in Menlo Park, California. I have worked at  
9 Exponent since November 2003.

10

11 Prior to working at Exponent, I held a series of positions with advancing  
12 responsibility in the areas of public health, occupational medicine, and academia. I  
13 was employed at the Oklahoma State Department of Health from 1972 to 1990 and  
14 held a series of positions culminating in my appointment as the State Epidemiologist,  
15 a post that I held from 1979 to 1982, followed by the position of Consulting  
16 Medical/Environmental Epidemiologist from 1983 to 1990. In both of these  
17 capacities, I directed epidemiologic investigations consisting of a broad range of  
18 health concerns, from food-borne outbreaks to cancer clusters.

19

20 I was a faculty member of the Department of Preventive Medicine at the Medical  
21 College of Wisconsin from 1990 to 1997, and I completed my tenure as Associate  
22 Professor and Acting Chairman of the Department. I have also served as Corporate  
23 Medical Director for several global companies. While on faculty at the Medical  
24 College of Wisconsin in Milwaukee, Wisconsin, I was contract Medical Director for  
25 Wisconsin Centrifugal, a foundry in Waukesha, Wisconsin. In this role, I supervised  
26 the health monitoring programs, both company-mandated and Occupational Safety  
27 and Health Administration ("OSHA") required, in addition to the day-to-day clinical  
28 aspects of the employee health service. My responsibilities included biological  
29 surveillance of employee population as well as worksite reviews and inspections.

30

31 I earned a M.Ed. in Education in 1972, an M.P.H. in Epidemiology and Biostatistics  
32 in 1974, and a Ph.D. in Epidemiology and Biostatistics in 1979. I completed medical  
33 school in 1986, an internship in Family Medicine in 1987, and a residency/fellowship  
34 in Occupational and Environmental Medicine in 1990.

35

36 I am a Fellow of the American College of Occupational and Environmental Medicine.  
37 I have unrestricted licenses to practice medicine in Oklahoma and Wisconsin. In  
38 addition to my employment experience, I am a past member (2000–2007, 2008–  
39 2011) of the Board of Directors, Vice President (2013-2014), and President (2015-  
40 2016) of the American College of Occupational and Environmental Medicine in  
41 Arlington Heights, Illinois. I have been a member of the Board of Directors of Vysis,  
42 Inc. in Downers Grove, Illinois and the Board of Scientific Counselors for the Agency  
43 for Toxic Substances and Disease Registry in Atlanta, Georgia. In addition, I have  
44 served as an active participant on numerous state and national professional  
45 committees. My statement of qualifications is attached as Exhibit 1.

46

47 **Q. Did you previously provide Direct Testimony in this docket?**

48 A. No.

49

50 **Q. What exhibits are attached to your Supplemental Direct Testimony?**

51 A. The following exhibit is attached to my Supplemental Direct Testimony:

- 52 • Exhibit 1: Statement of Qualifications.
- 53 • Exhibit 2: Letter, Kim Malsam-Rysdon, Secretary of Health, South Dakota  
54 Department of Health (Oct. 13, 2017), *In the Matter of the Application by*  
55 *Crocker Wind Farm, LLC for a Permit of a Wind Energy Facility and a 345*  
56 *kV Transmission Line in Clark County, South Dakota, for Crocker Wind*  
57 *Farm*, Docket No. EL17-055.
- 58 • Exhibit 3: Crichton, F., et al. (2014). The link between health complaints  
59 and wind turbines: Support for the nocebo expectations hypothesis.  
60 *Frontiers in Public Health* 2:220.

- 61 • Exhibit 4: Frits van den Berg, Public Health Service Amsterdam, and  
62 Irene van Kamp, National Institute for Public Health and the Environment  
63 (2017). Health effects related to wind turbine sound. Swiss Federal Office  
64 for the Environment.

65 **II. PURPOSE OF TESTIMONY**

66 **Q. What is the purpose of your Supplemental Direct Testimony?**

67 A. The purpose of my testimony is to briefly address the topic of potential health  
68 impacts from wind turbines, including those attributed to sound and shadow flicker.  
69 As discussed further in my testimony, no specific health condition caused by wind  
70 turbines has been scientifically proven in the peer-reviewed published literature.

71 **III. OVERVIEW OF HEALTH-RELATED WIND TURBINE RESEARCH**

72 **Q. Are assertions that wind turbines cause adverse health effects being**  
73 **considered?**

74 A. Yes. The multiple governmental reviews and reports of public health officials show  
75 that concerns related to wind turbines' potential for adverse health effects have been  
76 and are being taken quite seriously. Following are examples of articles published in  
77 journals employing a peer review process as well as state, national and international  
78 scientific panels' literature which summarizes the peer reviewed literature:

- 79 • Eja Pedersen, Högskolan I Halmstad (2003). Noise Annoyance 116 from  
80 Wind Turbines: A Review. Swedish Environmental Protection Agency.  
81 • Danish Energy Agency (2009). Wind Turbines in Denmark.  
82 • Australian National Health and Medical Research Council (2010). Wind  
83 Turbines and Health: A Rapid Review of the Evidence.  
84 • Stephen Chiles (2010). A new wind farm noise standard for New Zealand,  
85 NZS 6808:2010. Proceedings of 20th International Congress on  
86 Acoustics, ICA 2010.

- 87 • Massachusetts Departments of Environmental Protection and Public  
88 Health (2012). Wind Turbine Health Impact Study: Report of the  
89 Independent Expert Panel.<sup>1</sup>
- 90 • Australian National Health and Medical Research Council (2014). Review  
91 of Additional Evidence for NHMRC Information Paper: Evidence on Wind  
92 Farms and Human Health – Final Report.
- 93 • Crichton, F., et al. (2014). The link between health complaints and wind  
94 turbines: Support for the nocebo expectations hypothesis. *Frontiers in*  
95 *Public Health* 2:220. (Exhibit 3.)
- 96 • Wisconsin Wind Siting Council (2014). Wind Turbine Siting – Health  
97 Review and Wind Siting Policy Update.
- 98 • Australian National Health and Medical Research Council (2015).  
99 NHMRC Statement: Evidence on Wind Farms and Human Health.
- 100 • Australian National Health and Medical Research Council (2015).  
101 Systematic Review of the Human Health Effects of Wind Farms.
- 102 • Public Service Commission of Wisconsin (2015). Review of Studies and  
103 Literature Relating to Wind Turbines and Human Health. Prepared for the  
104 Wisconsin State Legislature.
- 105 • Hitomi Kimura, Yoshinori Momose, Hiroya Deguchi, and Nameki, Mimi  
106 (2016). Investigation, Prediction, and Evaluation of Wind Turbine Noise in  
107 Japan. Ministry of the Environment of Japan.
- 108 • Michaud, et al. (2016). Effects of Wind Turbine Noise on Self-Reported  
109 and Objective Measures of Sleep. *Sleep* 39:1.<sup>2</sup>
- 110 • Ministry for the Environment, Climate and Energy of the Federal State of  
111 Baden-Wuerttemberg, Germany (2016). Low-frequency Noise Incl.  
112 Infrasound from Wind Turbines and Other Sources. LUBW Landesanstalt  
113 fur Umwelt, Messungen and Naturschutz Baden-Wuerttemberg.

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<sup>1</sup> See Exhibit 2 of the Supplemental Testimony of Dr. Jeffrey Ellenbogen.

<sup>2</sup> See Exhibit 5 of the Supplemental Testimony of Dr. Jeffrey Ellenbogen.

- 114 • Letter, Kim Malsam-Rysdon, Secretary of Health, South Dakota  
115 Department of Health (Oct. 13, 2017), *In the Matter of the Application by*  
116 *Crocker Wind Farm, LLC for a Permit of a Wind Energy Facility and a 345*  
117 *kV Transmission Line in Clark County, South Dakota, for Crocker Wind*  
118 *Farm*, Docket No. EL17-055. (Exhibit 2.)
- 119 • Akira Shimada and Mimi Nameki (2017). Evaluation of Wind Turbine  
120 Noise in Japan. Ministry of the Environment of Japan.
- 121 • Colloca, L. (2017). Nocebo effects can make you feel pain: Negative  
122 expectancies derived from features of commercial drugs elicit nocebo  
123 effects. *Science*, 358(6359):44.
- 124 • French National Agency for Food Safety, Environment and Labor  
125 (“ANSES”) (2017). ANSES Opinion regarding the expert appraisal on the  
126 “Assessment of the health effects of low-frequency sounds and  
127 infrasounds from wind farms.”
- 128 • Frits van den Berg, Public Health Service Amsterdam, and Irene van  
129 Kamp, National Institute for Public Health and the Environment (2017).  
130 Health effects related to wind turbine sound. Swiss Federal Office for the  
131 Environment. (Exhibit 4.)
- 132 • Joseph Rand and Ben Hoen (2017). Thirty Years of North American wind  
133 energy acceptance research: What have we learned? Energy Analysis  
134 and Environmental Impacts Division, Lawrence Berkeley National  
135 Laboratory, Electricity Markets and Policy Group.

136

137 I note that the scientific panels reviewed peer-reviewed, published literature,  
138 governmental documents, and information they considered as scientifically valid.

139

140 **Q. Why is it important to utilize scientific methodology when there are case**  
141 **studies and/or personal testimonials asserting that wind turbines can cause**  
142 **adverse health effects?**

143 A. The scientific methodology is an accepted process used to evaluate population-  
144 based data, and make sound, scientifically supportable decisions. There have been

145 numerous examples where an agent first thought to be the cause of a disease was  
146 confirmed not to be so as a result of the scientific process of hypothesis generation,  
147 research, and peer review. For example, in the following instances associations  
148 between an exposure and disease were disproven: coffee and pancreatic cancer  
149 (Hart 2008,<sup>3</sup> Dong 2011<sup>4</sup>); silicone breast implants and autoimmune diseases  
150 (Hölmich et al. 2007)<sup>5</sup>; saccharin and bladder tumors (NCI 2018);<sup>6</sup> Bendectin and  
151 birth defects (McKeigue, et al. 1994).<sup>7</sup> In some instances, an alternative cause is  
152 proven: spicy food and ulcers (turns out many are caused by bacteria) (Abdulkarim  
153 2010).<sup>8</sup> Clearly, initial observations and hypotheses are not always supported by  
154 more thorough scientific investigation. Even strongly held beliefs by groups of  
155 people do not provide proof of causation and at times can be detrimental to the  
156 scientific process and to public health. A timely example of such a situation is the  
157 current belief by some that immunizations cause autism.

158

159 **Q. Have wind turbines been proven to cause adverse health conditions?**

160 A. No. Despite the attribution of various health events to wind turbines, there has not  
161 been a specific health condition documented in the peer-reviewed published  
162 literature or recognized by the medical community or professional societies as a  
163 disease caused by exposure to sound levels and frequencies generated by the  
164 operation of wind turbines. In written testimony I provided in prior proceedings  
165 before the South Dakota Public Utilities Commission, I noted that this is the

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<sup>3</sup> Andrew Hart, High Kennedy, and Ian Harvey (2008). Pancreatic Cancer: A Review of the Evidence on Causation. *Clinical Gastroenterology and Hepatology* 6: 275–282.

<sup>4</sup> Jie Dong, Jian Zou, and Xiao-Feng Yu (2011). Coffee drinking and pancreatic cancer risk: a meta-analysis of cohort studies. *World J. Gastroenterol* 17:1204–1210.

<sup>5</sup> Hölmich, et al. (2007). Breast implant rupture and connective tissue disease: a review of the literature. *Plast. Reconstr. Surg.* 120:62S-69S.

<sup>6</sup> National Cancer Institute, Artificial Sweeteners and Cancer, available at <https://www.cancer.gov/about-cancer/causes-prevention/risk/diet/artificial-sweeteners-fact-sheet> (last accessed February 13, 2019).

<sup>7</sup> McKeigue, et al. (1994). Bendectin and birth defects: I. A meta-analysis of the epidemiologic studies. *Teratology* 50:27-37.

<sup>8</sup> Abdulkarim, et al. (2010). Spices, herbal xenobiotics and the stomach: Friends or Foes? *World J Gastroenterology* 16(22): 2710-2719.

166 conclusion that has been reached by governments and public health officials when  
167 they have evaluated wind turbines' potential for adverse health effects.<sup>9</sup> In contrast,  
168 the subjective, non-specific complaints that have been raised, which show a great  
169 deal of variability, do not provide support for a science-based conclusion that wind  
170 turbines are the cause of adverse health effects.

171

172 **Q. Has the State of South Dakota addressed claims of an association between**  
173 **wind turbines and health effects?**

174 A. The State of South Dakota has not specifically studied alleged health effects and  
175 wind turbines. However, the Department of Health was asked to opine on the issue  
176 in another docket, *In the Matter of the Application by Crocker Wind Farm, LLC for a*  
177 *Permit of a Wind Energy Facility and a 345 kV Transmission Line in Clark County,*  
178 *South Dakota, for Crocker Wind Farm, Docket No. EL 17-055. The South Dakota*  
179 *Secretary of Health, Kim Malsam-Rysdon, submitted a letter consistent with my*  
180 *testimony (Exhibit 2):*

181 The South Dakota Department of Health has been requested to comment  
182 on the potential health impacts associated with wind facilities. Based on  
183 the studies we have reviewed to date, the South Dakota Department of  
184 Health has not taken a formal position on the issue of wind turbines and  
185 human health. A number of state public health agencies have studied the  
186 issue, including the Massachusetts Department of Public Health<sup>10</sup> and the  
187 Minnesota Department of Health. These studies generally conclude that  
188 there is insufficient evidence to establish a significant risk to human  
189 health. Annoyance and quality of life are the most common complaints  
190 associated with wind turbines, and the studies indicate that those issues  
191 may be minimized by incorporating best practices into the planning  
192 guidelines.

193 **IV. WIND TURBINES AND SOUND**

194 **Q. Are you aware of any health concerns being raised in this docket with respect**  
195 **to wind turbines and sound?**

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<sup>9</sup> Pre-filed Supplemental Testimony of Dr. Mark Roberts, SD PUC Docket EL18-026, pp. 12-13 (Aug. 10, 2018) and Prefiled Testimony of Mark Roberts, SD PUC Docket EL18-003, pp. 10-12 (Apr. 6, 2018).

<sup>10</sup> See Exhibit 2 of the Supplemental Testimony of Dr. Jeffrey Ellenbogen.



196 A. I am aware that comments prepared by Richard James regarding alleged infrasound  
197 and low frequency noise health impacts from wind projects were filed in the docket  
198 by George and Ruby Holborn.

199

200 **Q. Do you agree with Mr. James' comments?**

201 A. I agree with Mr. James that wind turbines produce audible sound, infrasound, and  
202 low frequency sound. However, Mr. James' comments regarding potential health  
203 effects from wind turbine noise are not supported by the peer-reviewed literature  
204 discussing studies of the potential health effects of wind turbines that utilize the  
205 scientific methodology. He is merely using findings in other scientific areas to  
206 support a hypothesis that is unproven and unfounded in basic science.

207

208 **Q. Based on your review of the available scientific literature, are there potential**  
209 **adverse health effects from the audible sound of wind turbines?**

210 A. No, not at the levels of sound that will be produced by this Project. Substantial  
211 research has been done on sound level exposures to humans. This body of  
212 scientific research has identified a number of health-related links to high level  
213 industrial sound in the workplace. For example, OSHA has set a limit of 90 dBA for  
214 the 8-hour work day based on a finding that exposure to levels of noise above 90  
215 dBA in the workplace can cause hearing damage and set an 85 dBA level as the set  
216 point of initiation of a hearing protection program in the workplace. However, this  
217 same science has not identified a causal link between any specific health condition  
218 and exposure to the sound patterns generated by contemporary wind turbine  
219 models. In addition to my own conclusions, several other respected organizations  
220 and agencies have reached similar conclusions.<sup>11</sup>

221

222 **Q. What is infrasound?**

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<sup>11</sup> See Pre-filed Supplemental Testimony of Dr. Mark Roberts, SD PUC Docket EL18-026, pp. 12-14 (Aug. 10, 2018), and Prefiled Testimony of Dr. Mark Roberts, SD PUC Docket EL18-003, pp. 11-13 (Apr. 6, 2018).

223 A. Infrasound, sometimes referred to as low frequency sound, is sound that is between  
224 0 hertz (“Hz”) and 20 Hz. Although the human hearing threshold has been found to  
225 be as low as 4 Hz in an acoustic chamber, a level of 20 Hz is commonly considered  
226 the low end of the range of hearing.

227

228 **Q. Is there reliable evidence that infrasound from wind turbines causes adverse**  
229 **health effects?**

230 A. No, I am not aware of any such evidence. Multiple health experts, in individual peer-  
231 reviewed publications or as part of public health type advisory panels, have  
232 confirmed this point. Specifically, infrasound at frequencies lower than 20 Hz are  
233 audible at very high levels (110+ dBA), and these sounds may occur from man-  
234 made but also many natural sources, such as meteors or volcanic eruptions.  
235 Anthropogenic (i.e., human-caused) sources, which often are the predominant type  
236 of sound, can also generate infrasonic noise (e.g., heart, lung and digestive tract  
237 sounds as well as machinery, ventilation systems, large combustion processes and  
238 naturally occurring winds).<sup>12</sup> Heart sounds are in the range of 27 to 35 dBA at 20-40  
239 Hz<sup>13</sup> and lung sounds are reported in the range of 5-35 dBA at 150-600 Hz.<sup>14</sup> Note  
240 that these sources are in the range of infrasound produced by wind turbines. Thus,  
241 infrasounds – both man-made and naturally-occurring – are all around us.

242

243 **Q. Are you aware of assertions that infrasound from wind turbines can cause**  
244 **adverse health effects?**

245 A. Yes, as I noted, Mr. James makes generalized claims of adverse health effects  
246 which are based on self-reported symptoms that have not been objectively

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<sup>12</sup> Berglund, B., Hassmen, P., and Job, R. F. (1996). Sources and effects of low-frequency noise. *Journal of the Acoustical Society of America*. 99(5), (2985-3002); Leventhall, G. (2007). What is infrasound? 93(1-3), (130-137); Sienkiewicz, Z. (2007). Rapporteur report: Roundup, discussion and recommendations. *Progress in Biophysics and Molecular Biology*. 93(1-3), (414-420).

<sup>13</sup> Sakai, A., Feigen, L. P., and Luisada, A. A. (1971). Frequency distribution of the heart sounds in normal man. *Cardiovascular Research*. 5(3), (358-363).

<sup>14</sup> Fiz, J. A., Gnitecki, J., Kraman, S. S., Wodicka, G. R., and Pasterkamp, H. (2008). Effect of body position on lung sounds in healthy young men. 133(3), (729-736).

247 evaluated. His claims lack clinical or scientific merit. In addition, the publications by  
248 Dr. Paul Schomer upon which Mr. James relies did not use epidemiologic study  
249 methods such that specific conclusions could be scientifically supported or  
250 demonstrate a causal relationship between wind turbines and health complaints  
251 reported by some residents. As I explained above, and in detail in my testimony in  
252 prior proceedings before the Commission, use of the scientific methodology, such as  
253 that used in a well-designed epidemiologic study, is essential for a study's results to  
254 be reliable in terms of identifying a potential causal relationship.<sup>15</sup>  
255

256 **Q. In his comments, Mr. James relies upon the Shirley Wind Farm in Wisconsin to**  
257 **support his opinion that a 38 dBA (Leq) sound limit should be imposed on**  
258 **wind farms by local governments. Is this reliance justified?**

259 A. In my opinion, no. None of the claims relating to the Shirley Wind Farm in Brown  
260 County, Wisconsin, which was built in 2011 and consists of eight 2.5 megawatt wind  
261 turbines, have been confirmed by a physician. Also, in December 2015, the Brown  
262 County health officer (Ms. Chau Xiong) declared that there was insufficient scientific  
263 evidence to support the relationship between wind turbines and health concerns.<sup>16</sup> I  
264 believe that further allegations of health effects based on the Shirley Wind Farm are  
265 unfounded.

266 **V. WIND TURBINES AND SHADOW FLICKER**

267 **Q. Have you evaluated the potential for shadow flicker from wind turbines to have**  
268 **health effects?**

269 A. Yes. I found no scientific studies indicating any demonstrated health effects arising  
270 from shadow flicker produced by wind turbines, or any other type of flicker humans  
271 commonly experience, such as from computer monitors, TV screens or fans. With

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<sup>15</sup> Pre-filed Supplemental Testimony of Dr. Mark Roberts, SD PUC Docket EL18-026, pp. 9-12 (Aug. 10, 2018) and Prefiled Testimony of Dr. Mark Roberts, SD PUC Docket EL18-003, pp. 8-10 (Apr. 6, 2018).

<sup>16</sup> Proceedings of the Board of Health Special Meeting, UW Extension, Green Bay, Wisconsin, December 15, 2015, available at: [http://www.co.brown.wi.us/i\\_brown/minutes/895edb5ae8ce/boh\\_minutes\\_12-15-15\\_draft\\_2.pdf](http://www.co.brown.wi.us/i_brown/minutes/895edb5ae8ce/boh_minutes_12-15-15_draft_2.pdf).

272 respect to claims that shadow flicker from wind turbines may affect persons with  
273 epilepsy, there is no indication that a wind turbine would have an impact because  
274 the frequency of shadow flicker from wind turbines is not the frequency that induces  
275 epileptic seizures. Specifically, the Epilepsy Foundation has stated that light flashing  
276 frequencies greater than 10 Hz (600 RPM) may trigger epileptic seizures but  
277 seizures are unlikely at less than 2 Hz (120 RPM). This level is well below the usual  
278 wind turbine operation blade passage frequency of approximately 0.5 Hz (30 RPM).

279  
280 **Q. Are you aware of shadow flicker limits that have been imposed on wind**  
281 **turbines?**

282 A. Yes. There are state and national jurisdictions that have imposed shadow flicker  
283 limits. The typical limit I have seen is 30 hours annually. However, such  
284 requirements and recommendations have no scientifically supported health-based  
285 justifications.<sup>17</sup>

286  
287 **Q. Are you aware of any health-related reason to impose a certain shadow flicker**  
288 **limit on this project?**

289 A. No. I am not aware of any health-based justification for setting any limit on shadow  
290 flicker, as there is no scientific evidence that shadow flicker causes health effects.

291 **VI. OTHER HEALTH ISSUES RAISED IN PUBLIC COMMENTS**

292 **Q. Apart from the issues already discussed in this testimony, are you aware of**  
293 **any public comments submitted in this docket thus far regarding health**  
294 **concerns?**

295 A. Yes. The following articles regarding wind turbines and human health were  
296 submitted or referred to in public comments:

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<sup>17</sup> Haugenm, K. M. B. (October 19, 2011). International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences: Setbacks, Noise, Shadow Flicker, and Other Concerns. Minnesota Department of Commerce: Energy Facility Permitting. See also Knopper, L. D., Ollson, C. A., McCallum, L. C., Whitfield Aslund, M. L., Berger, R. G., Souweine, K., and McDaniel, M. (2014). Wind turbines and human health. *Frontiers in Public Health*, 2(63):1–20.

- 297
- A letter posted on National Wind Watch by Hakan Enbom, M.D., Ph.D.,  
298 titled “Infrasound from wind turbines can trigger migraine and related  
299 symptoms” (the “Enbom Letter”).
  - A report compiled by Carmen Krogh, PSCPharm, titled “Industrial Wind  
300 Turbines and Health: Wind Turbines Can Harm Humans if too Close to  
301 Residents” (the “Krogh Report”).
  - A report by Jerry L. Punch and Richard R. James titled “Wind Turbine  
302 Noise and Human Health: A Four-Decade History of Evidence that Wind  
303 Turbines Pose Risks” (the “Punch and James Report”).
  - An article posted on National Wind Watch by Hakan Enbom and Inga  
304 Malcus Encom titled “Infrasound from wind turbines – an overlooked  
305 health risk” (the “Enbom Article”).  
306  
307  
308  
309

310 **Q. Please describe the Enbom Letter.**

311 A. The Enbom Letter is a discussion of divergent medical concepts not related to wind  
312 turbine sound or exposure and proposing a causation hypothesis. A review of the  
313 scientific articles they list in the referenced article does not indicate that their  
314 hypothesis is proven. The article shows a pattern of applying concepts out of  
315 context and/or not directly applicable to wind turbine sound (as I discuss in more  
316 detail below).

317

318 **Q. What is your response to the Enbom Letter?**

319 A. While the Enbom Letter includes small pieces of recognized science references, the  
320 author fails to acknowledge that no reliable scientific publications support the  
321 author’s hypotheses. A review of the references also reveals statements that  
322 contradict Dr. Enbom’s hypothesis, including:

- **Farboud 2013:** This article states that “[t]here is an abundance of  
323 information available on the internet describing the possibility of wind  
324 turbine syndrome. However, the majority of this information is based on  
325 purely anecdotal evidence. Whilst it is biologically and physically plausible  
326 that low frequency noise generated by wind turbines could affect people,  
327

328 there is insufficient evidence on which to base conclusions. The fact that  
329 the ear may respond to low frequency noise at the frequency and levels  
330 generated by wind turbines does not necessarily mean that such noise will  
331 be perceived or will disturb function.” (Farboud 2013, p. 225.)<sup>18</sup>

332  
333 • **Shepherd 2011:** This article explains, “[o]f further interest are the likely  
334 mechanisms involved in the degradation of [health-related quality of life]  
335 when exposed to turbine noise. Studies show that the level of turbine  
336 noise is a poor predictor of human response, and dose-response  
337 relationships typically explain little of the association between turbine  
338 noise and annoyance.” (Shepherd 2011, p. 337.)

339  
340 • **Woolf 2011:** This reference does not mention wind turbines and thus does  
341 not say anything about wind turbines and specific adverse health effects.  
342 (Woolf 2011.)<sup>19</sup>

343  
344 • **Todd 2009:** This reference makes observations about 100 Hz vibrations at  
345 70dB which are significantly different from that produced in the typical  
346 wind turbine. In addition, Todd has cautioned about applying his work to  
347 the wind turbine claims. (Todd 2009.)<sup>20</sup>

348

349 **Q. Please describe the Krogh Report.**

350 A. The Krogh Report is a collection of material from various sources which offer  
351 opinions but do not include reliable scientific analysis showing an adverse health  
352 effect associated with wind turbines.

353

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<sup>18</sup> Farboud, et al. (2013). Wind turbine syndrome: fact or fiction? *J. Laryngol Otol.* 127(3):222-6.

<sup>19</sup> Clifford J. Woolf (2011 Mar.). Central sensitization: Implications for the diagnosis and treatment of pain. *Pain.* 152 (3 Suppl): S2-15.

<sup>20</sup> Neil Todd (2009). Hot Topic 1: Low frequency sensitivity of the vestibular system and its significance. Hot Topics in Vestibular Research. Manchester, UK.

354 **Q. What is your response to the Krogh Report?**

355 A. The Krogh Report is neither reliable nor helpful. It is nothing more than a listing of  
356 documents that appear to be favorable to a hypothesis that, as the article is titled,  
357 “[w]ind turbines can harm humans if too close to residences.” The Krogh Report  
358 does not analyze its sources reliably, and the “sources” appear to be a mix of  
359 personal opinion pieces, lay articles, articles promoted by organizations whose sole  
360 goal is to stop wind development, and other articles that do not show any link  
361 between wind turbines and adverse health effects. None of these sources appears  
362 to be peer-reviewed, evidence-based, or reliable.

363

364 **Q. Please discuss your response to the Punch and James Report.**

365 A. Although its authors claim that it is a “systematic review of legitimate sources,” the  
366 Punch and James Report is not a peer-reviewed article and is, at best, simply a  
367 more carefully-crafted collection of “sources” than the Krogh Report. It  
368 systematically excludes and ignores a majority of the articles published in peer-  
369 reviewed journals on this topic. The Punch and James Report weaves a strong anti-  
370 wind narrative of articles favorable to opinions of its authors that is contrary to the  
371 numerous reviews by state, national and international organizations which they  
372 dismiss as biased. Like the Krogh Report, it is neither reliable nor helpful – it has not  
373 been published in a peer-reviewed, scientific journal and thus has not been  
374 objectively reviewed in an unbiased fashion.

375

376 **Q. Overall, in your professional opinion, do any of the above references from**  
377 **public comments show a connection between wind turbines and adverse**  
378 **human health effects?**

379 A. No. These references do not provide scientifically-based evidence that wind turbines  
380 adversely affects the physical wellbeing of residents. As I discuss previously in this  
381 testimony, the scientifically-based evidence weighs in favor of the opposite  
382 conclusion – that there is no relationship between wind turbines and adverse health  
383 effects.

384 VII. CONCLUSION

385 Q. Does this conclude your Supplemental Direct Testimony?

386 A. Yes.

387

388 Dated this 14th day of February, 2019.

389

A handwritten signature in black ink, appearing to read "Mark A. Roberts MD". The signature is written in a cursive style and is positioned above a solid horizontal line.

390

391 Dr. Mark Roberts

392

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