Appendix I – The Impact of Wind Power Projects of Residential Property Values in the United States: An Overview of Research Findings

The Impact of Wind Power Projects on Residential Property Values in the United States: An Overview of Research Findings

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With reference to

South Dakota
Wind Facilities

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January 20, 2017

Impact of Wind Power Projects on Residential Property Values in the United States: An Overview of Research Findings

Introduction

This primary objective of this report is to provide: (1) a summary are the two Lawrence Berkeley National Laboratory (LBNL) national hedonic studies that investigate the impact of wind facilities on nearby property values, including a summary of and response to criticisms of the these studies; (2) a summary of additional academic literature pertaining to the wind development / property value relationship in the United States; and (3) a summary of and criticisms of an "alternative literature."

The LBNL National Hedonic Studies

- LBNL conducted the following large-scale studies to determine whether or not wind developments had a significant effect on nearby property values.
    - "The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis" (B. Hoen, R. Wiser, P. Cappers, M. Thayer, and G. Sethi), December 2009 – analysis of 7,459 home sales; and
    - "A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States" (B. Hoen, J.P. Brown, T. Jackson, R. Wiser, M. Thayer, and P. Cappers), August 2013 – analysis of 51,262 home sales, with 1,198 within one mile of a turbine.

- The 2009 LBNL study focused on property value concerns for wind energy that fall into three categories. Each of these effects could impact property values and the effects are not mutually exclusive.
    - Area Stigma – concern that surrounding areas will appear more developed.
    - Scenic Vista Stigma – concern over decrease in quality of scenic vistas from homes.
    - Nuisance Stigma – concern that factors that occur in **close** proximity will have unique impacts.

- The 2013 LBNL study focused only on area stigma and nuisance stigma.

- The wind turbine / property value relationship was primarily studied using a statistical method called the Hedonic Price Model.

- The hedonic pricing model has been used by economists and real estate practitioners for over 40 years and has the following attributes:
    - Uses actual market data to infer value – there is no attempt to appraise values.

- Designed to place an economic value on specific characteristics of a home (e.g., value of an additional bathroom, a pool, or view of wind turbines).
- Uses a large # of home sales (many thousands).
- Controls (holds constant) a large number of possibly confounding variables (everything under the sun).
- Uses data from a large area to obtain enough variation in all characteristics.
- Can use data from a restricted period of time (cross-sectional analysis) or an extended period of time (time-series analysis) – note that this latter case requires adjustment to constant dollars.
- Can be used effectively to appraise homes due to extensive data set – however, constantly updating the data set is expensive and time consuming.
- Hedonic pricing is essentially a very large "Paired Sales" analysis with sufficient home sales and controls.

- The hedonic pricing model requires information on large number of sales and corresponding sales prices and home characteristics, which include

    - Quantity Measures (e.g., square feet of living area, lot size, # of bathrooms, bedrooms, etc.).
    - Quality Measures (e.g., # of fireplaces, condition of home, presence of pool, air conditioning, scenic vista, etc.).
    - Location Specific Variables (e.g., local school quality, demographics, socioeconomic status, distance to important activities, environmental quality measures, etc.).
    - Variables of Interest (e.g., view of wind turbines, distance to wind turbines).

- Either Qualitative Ratings (e.g. dominance of view of wind turbines) or distance to the nearest turbine at time of home sale is used to measure the possible dis-amenity from wind turbines.

- The 2009 LBNL study used home sales data from ten areas surrounding twenty-four wind facilities in nine states. In total, 7,459 residential sales transactions (1,754 pre-announcement, 768 post-announcement / pre-construction, and 4,937 post-construction) were analyzed.

- The 2009 LBNL research reached to following primary conclusion. Risks of property value impacts are often expected but **all** research suggests that property value impacts related to view and distance are not significantly different from zero. Specifically,

    - **Area Stigma – no statistical evidence** that sales prices of homes near wind facilities are significantly affected by those facilities as compared to other homes in the region.

- **Scenic Vista Stigma – no statistical evidence** that sales prices of homes with a view of the turbines are significantly affected (i.e., stigmatized) even if the view is "extreme."
- **Nuisance Stigma – no statistical evidence** that sales prices of homes within a mile of the nearest wind turbine are significantly affected by those facilities as compared to other homes in the region.
- **Timing** – **no statistical evidence** of a trend in sales prices of homes near turbines that is consistent with scenic vista, area, or nuisance stigma.

- Results from Alternative Models

  - **Repeat Sales Model** – appreciation rates for homes near the wind farms are not significantly different than appreciation rates for homes located farther from the wind farms.
  - **Sales Volume Analysis** – no statistical evidence that the sales volume of homes near wind farms is different than the sales volume of homes located farther from the wind farms.

- Regardless of the dataset or specification, none of the 2009 LBNL research found evidence that homes near operating or announced wind turbines was impacted in a statistically significant fashion. In addition, this initial LBNL study was most comprehensive, data rich analysis conducted to that time.

- The results of the 2009 LBNL study are buttressed by extensive robustness testing. Results are reported for different samples (e.g., VISTA and VIEW overlap model, temporal model, etc.), different pooling alternatives, various functional forms, inclusion/exclusion of various independent variable sets, inclusion/exclusion of outliers, etc. In effect, Hoen, et al search deep and wide to identify an effect and explore alternative explanations. In no case did proximity to and/or views of wind turbines significant affect the sale prices of nearby residential properties.

- In spite of the overwhelming evidence that wind developments had no appreciable effect on nearby property values the LBNL researchers were commissioned to conduct a second study in order to accomplish the following objectives: (1) Expand the overall sample size in order to possibly find relatively small effects; (2) expand the number of sales transactions within close proximity of turbines; and (3) conduct advanced spatial econometrics and sophisticated difference-in-difference analysis. This 2013 study utilized 51,276 Home sales from 27 U.S. counties related to 67 wind facilities, and 1,198 home sales were within one mile of a wind turbine.

- Regardless of the dataset or specification, the 2013 LBNL study **no evidence** that homes near operating or announced wind turbines are impacted in a statistically significant fashion.

Summary of and Response to Criticisms of the LBNL Studies

- The two LBNL studies, and to a lesser extent the entire academic literature) have received some criticism, mostly in the form of internet postings (i.e., not in the academic literature) and in the testimony of Michael McCann before various local and state decision bodies. Of course, McCann has also testified that he lacks any credentials related to statistics, statistical modeling, the hedonic price method, etc. Moreover, McCann has consistently demonstrated confusion over statistical significance and its relation to R^2 values, confusion over explanatory variables / independent variables and confusion over the interpretation and meaning of R^2 values.

- Despite this lack of expertise McCann continues to offer criticisms of the hedonic literature that relates proximity to and views of wind turbines to residential property values. For example, he claims that

    - R^2 values for hedonic studies are too low;
    - pooling across study areas creates a broadening of the standard deviation;
    - previous studies have eliminated relevant data;
    - hedonic studies have included program participants; and
    - hedonic studies are biased because studies are funded by wind proponents (the United States Department of Energy).

- The LBNL response to these types of criticisms can be found in Appendix A below.

Academic Literature Overview

- In addition to the two LBNL studies there have been six large empirical studies completed since December 2009 that examined the impact of wind farms on nearby property values in the United States:

    - "Wind Farm Proximity and Property Values: A Pooled Hedonic Regression Analysis of Property Values in Central Illinois" (J.L. Hinman) May 2010 – analysis of 3,851 home sales;
    - "The Effect of Wind Farms on Residential Property Values in Lee County, Illinois" (J. Carter), 2011 – analysis of 1,298 home sales;
    - "Values in the Wind: A Hedonic Analysis of Wind Power Facilities" (M.D. Heintzelman and C.M. Tuttle), July 2011 – analysis of 11,331 home sales;
    - "Impact of the Lempster Wind Power Project on Local Residential Property Values" (M. Magnusson and R. Gittell), January 2012 – analysis of 2,593 home sales;

- "Relationship between Wind Turbines and Residential Property Values in Massachusetts" (C. Atkinson-Palombo and B. Hoen), 2014 – analysis of 122,198 home sales, with 6,081 within one mile of a turbine;
- "Effects of Wind Turbines on Property Values in Rhode Island" (Lang, Opaluch, and Sfinarolakis), 2014 – analysis of 48,554 home sales, with 3,254 within one mile of a turbine; and

- These studies all use similar methodologies (hedonic price method) and data and, remarkably, come to the exact same conclusion. Specifically all large-scale, empirical studies of U.S. wind facilities conclude that, post-construction/operation, there is **no identifiable effect** of wind power projects on nearby residential property values. This conclusion is based on the evaluation of 248,560 actual home sales in eight studies.

- Three of the studies suggest that there may be negative property value effects in the post-announcement / pre-construction phase. This effect has been labeled "anticipation stigma" by Hinman. However, in all studies these anticipation effects are transitory and disappear once the operation of the wind farms commences.

- The literature is based on the premise that proximity to and views of environmental (dis)-amenities can impact nearby residential property values. This linkage has been extensively studied over the last 40 years.

- Based on this extensive literature, the planned wind projects in South Dakota will not significantly reduce the sales prices of properties in the neighborhood of the wind facilities.

Alternative Literature

- There is an alternative "literature" characterized by

  - Small, unrepresentative, non-transparent samples in which the data selection process is undefined.
  - Anecdotal information.
  - Data sets that are a mis-matched combination of sales, appraisals, and assessments.
  - Analysis of vacant land rather than residential home values.
  - Insufficient controls for important influences.
  - Inappropriate analytical methods.

- This alternative literature does not possess the required scientific rigor and thereby should be considered useless for determining the effect of wind turbines on nearby residential property values.

- This alternative literature has formed the basis for testimony by Michael McCann, who has offered basically the same testimony in a multitude of settings – specifically, residential properties located within three miles (or possibly greater distances) of wind turbines will experience a minimum 25 – 40 percent reduction in value for homes.

    - Note that this is a minimum expected loss as McCann has on several occasions suggested that the loss could be significantly greater. In fact, in a publication/statement entitled "I Predict a Series of Rural Ghettos – Abandoned, Unmaintained Homes (Ill)," McCann stated in 2010 that the only thing worse than wind turbines for creating the physical and health-driven need to relocate is a nuclear reactor meltdown (e.g., Chernobyl) and indicated that damages to homes could be in the 60 – 80 percent range. Of course, no justification was provided for that damage range.

    - The expected reductions in value are based on (1) McCann's own analysis; (2) an alternative literature; and (3) McCann's willful mis-interpretation / mis-understanding of the existing hedonic literature in which he demonstrates a complete lack of knowledge concerning statistics and hedonic methods and draws erroneous conclusions that are exactly opposite of the conclusions drawn by the authors of specific reports. Consider each of these elements below.

McCann's Own Analysis

- McCann has conducted (at least) four "studies"

    - Lee County, Illinois in 2010 – 68 data points chosen from the years 2003-2005, with 16 observations within the wind farm footprint and 52 observations outside the footprint
        - Very small sample.
        - Jason Carter (2011) examined the same area and reported 3,200 sales between 2002 and 2010 (or about 356/year).
        - Even if one excludes observations that are questionable, Carter found 1,298 observations over the nine year period (144/year).
        - Sample selection process used by McCann is questionable.
        - McCann only reports raw averages for the variable of interest (price/ft^2) and does not make any adjustments for housing characteristic differences.
        - Complete failure to account for many possible confounding variable (e.g., location, house amenities, neighborhood amenities, etc.).
        - The Carter study, which is based on a much larger and complete data set concludes that wind farms have no effect on the sale prices of wind farms on nearby properties.

    - Lee County, Illinois and DeKalb County, Illinois – paired sales analysis with extremely small data sets (fourteen observations in Lee County, nine observations in DeKalb County).
        - Selection process is not transparent.

        - Adjustments for some characteristics (acreage, presence of basement or outbuildings) but failure to account for obvious confounding variables.
        - Monetary adjustments are completely without foundation.

    - Livingston County, Illinois in 2015 – paired sales analysis with 17 target home sales and 50 control sales.
        - Data set is small and not representative of the population of home sales.
        - Control sites are often inconsistent attribute-wise relative to target sites (e.g., age of home, acreage, condition) and, contrary to McCann's statements, include questionable choices (foreclosed homes, not arms-length sales, etc.).
        - Adjustments for some characteristics (acreage, presence of basement or outbuildings) fails to account for obvious confounding variables.
        - Monetary adjustments for variation in house characteristics are variable (i.e., subjective) and lack any supporting documentation.

- Overall, McCann's studies are cursory investigations using raw averages and paired sales methods in Illinois.

    - Each of these analyses is beset with the same range of problems (e.g., small samples, undefined sample selection methods, simple statistical measures, failure to account for obvious confounding factors, subjective monetary adjustments applied inconsistently, etc.).
    - Conclusions of such work are without foundation and completely lacking in scientific rigor.
    - Results are based on specific locations, specific local influences, and specific adjustment factors and, even if done with scientific rigor, would not be transferable to any other situation.

- McCann's work completely lacks any sensitivity or robustness analysis. Only one assessment procedure is provided, one that always agrees with his initial previous work and never explores the impact on his conclusions of different samples, different selection methods, different adjustment factors.

McCann Use of the Alternative Literature to Support His Conclusions

- In addition to McCann's own work he also relies on an alternative "literature" on the effect of wind turbines on nearby residential property values. This literature includes studies conducted by Kielisch (2011), Gardner (2009), Sunak and Madlener (2012), and Lansink (2012). As indicated above, this alternative literature is characterized by:

    - small, unrepresentative, non-transparent samples in which the data selection process is undefined.
    - anecdotal information.

- data sets that are a mis-matched combination of sales, appraisals, etc.
- reliance on of vacant land values rather than residential home values (e.g., Kielisch; Gardner; Sunak and Madlener; Jensen, et al; Gibbons).
- insufficient controls for important influences; and
- inappropriate analytical methods.

- The Lansink study near the Melancthon wind farm in Canada found a 38.81% reduction in home values near the wind farms.

    - Sample of 12 properties (Clear Creek = 7, Melancthon = 5).
    - Actual sales prices to a MLS-based average with no accounting for differences in house characteristics so one cannot evaluate whether any of the differences between sale price and the MLS average can be explained by home specific characteristics, neighborhood amenities, etc.
    - In response to the resident's fears and the Lansink study, Vyn and Fraser (2013) conducted a large-scale analysis of the Melancthon wind farm, applying the hedonic price approach to detailed data on 5,414 rural residential and 1,590 farmland sales and examined both proximity to turbines and turbine visibility.
    - The results of the hedonic models, which were robust to alternate model specifications, including repeat sales analysis, suggest that **wind farms do not significantly impact nearby property values**.
    - Lansink "study" was trumped by a real study.
    - Also, in response to resident's concerns the Municipal Property Assessment Corporation (MPAC) conducted a large scale study of assessments in Ontario (2012) and concluded that there is **no statistically significant impact** on sale prices of residential properties in market areas within close proximity of an industrial wind turbine.

- "Wind Turbines and Property Value" (2011) by Appraisal Group One (Kielisch)

    - Vacant land near wind turbines suffers a reduction in value in the range of 12 – 40 percent.
    - Kielisch compared vacant land in the wind farm foot print (6 observations) to vacant land outside the foot print (62 observations) for a wind farm in Wisconsin using paired sales.
    - Small data set.
    - A Wisconsin appraiser, who was familiar with the area, reported that the inside the foot print properties were standard rural land whereas the outside the foot print properties were in an improved sub-division with roads, utilities, etc. and had another locational advantage – they were located on the largest lake in Wisconsin.
    - So much for "paired sales."
    - The study is about vacant land – not really applicable to residential home values.
    - Study completely misused paired sales analysis and misinterpreted the results.

- Study also reports on some survey work but it is impossible to tell whether or not the survey meets any standard of reasonableness with regard to sample selection, survey design, etc.

- Three studies that were conducted in European countries (Sunak and Madlener in Germany, Gibbons in the United Kingdom, and Jensen, et al in Denmark)

    - Each of these studies finds significant impacts of wind turbines on nearby property values, even though they utilize a variety of methods.
    - It is not clear that these studies are relevant to wind turbine developments in the United States due to differences in homeowner and community compensation levels (significantly greater in the United States), the overall impact on the local environment (likely smaller in the United States due to more extensive review processes), and the working landscape (more large scale developments in the United States with established approval processes).
    - McCann has never attempted to elucidate how/why and under what conditions these studies are pertinent to the assessment of wind farm developments in North America.
    - These studies have additional problems such as: (1) Sunak and Madlener examine the value of land rather than the full value of residential properties; and (2) Gibbons' finding of negative impacts are associated with turbine visibility (not area or nuisance stigma) – however, the study does not actually measure visibility of turbines – rather the author uses a digital elevation model to "estimate" visibility based on elevation differences – thus the estimated view sheds take **no account** of any intervening buildings, trees, or any structures so it is not obvious that the treatment is measured without gross errors.
    - McCann makes no effort to understand the limitations and appropriateness of these studies.

McCann's Mis-interpretation of Hedonic and/or Statistical Studies

- McCann makes a completely false statement (and repeats everywhere) about the Hinman (2010) study. He states that "values near wind farm appreciated $13,524 after operation, following $21,916 decline measured under anticipation stigma theory. (Net loss of $8,392 pre- vs. post operation / Hinman, Pg. 120.)" In the example that Mr. McCann is referring to, Hinman is explaining how to calculate the price effects using a two-stage model (the two stages are pre-announcement and post-construction so note that there is no allowance for the anticipation period). Hinman's basic conclusion is that homes near wind farms suffered from a "location effect" and were depressed **prior** to wind farm development (-$21,916) and appreciated after development (+$13,254) more than homes farther away. Note this means that proximity to wind turbines did not decrease property values – rather proximity increased property values. This is exactly what the 2009 Hoen, et al study found. Note that there is no discussion of "anticipation effect" in this Hinman calculation. On Page 121 of Hinman, she does examine a three-stage model in which the anticipation stage is included. In this case, homes near wind farms started out selling for less (-$20,323) than homes farther away (location effect), depreciated (-$3,977) more than

properties farther away during the post-announcement/pre-construction stage (anticipation effect), but appreciated $11,931 more than homes farther away post-construction. Either McCann is being completely disingenuous or he misunderstood the examples in Hinman.

- McCann draws a completely incorrect conclusion from Table 7 in the 2013 Hoen, et al study. The table provides evidence that homes within a mile of a turbine (post-construction) sell for approximately 28% less than homes more than three miles from a turbine. The point of this table is to demonstrate explicitly that simplistic comparisons (like appraisers do with their paired sales analysis and McCann did in the Lee County, Dekalb County, and Livingston County studies) can lead to uninformed, erroneous conclusions. In this case, homes within one mile are (for example) smaller, on larger lots, and are older than homes outside three miles. There are many other possible differences between the groups of homes as well (e.g., sales timing, census tract variables, as measures of neighborhood quality, etc.). When one accounts for all these differences the 28% sale price difference disappears – that is why one uses a sophisticated empirical model rather than a simple comparison with inadequate controls. Yet, McCann argues that the 28% difference is the "smoking gun" and it is obvious that Hoen, et al (2013) has used statistics to eliminate a true price effect.

- McCann makes a similar error when he examines the MPAC study (2012). MPAC conducted a two-part study, one that compared assessed values to sales vales (for assessment equity purposes) and a second one that examined actual sales transactions vis-à-vis proximity to industrial wind turbines (IWT). In the first study MPAC presents a histogram that examines assessment/sales ratios by proximity to an IWT. The point is to show that, regardless of proximity to an IWT, the assessment/sales ratios are very close to one, so there is no apparent equity issue in the assessments. McCann ignores the purpose of the histogram and focuses on the magnitude of sales prices by proximity to wind turbines. The histogram shows that homes outside 5 kilometers sell for over $220,000 and homes that are within 1 km distance sell for around $170,000 (approximate $50,000 or 22% loss in the McCann world). However, this difference does not control for potential differences in the homes by proximity. When these home characteristic differences are taken into consideration (the purpose of the second portion of MPAC study) there is **no significant difference in home sale prices by proximity to an IWT**. When apprised that his conclusion was exactly opposite the conclusion offered by the authors of the MPAC report McCann has stated that he was only looking at the data and that it seemed implausible to him that any confounding variables were relevant. Further he argued that for the MPAC conclusions to be correct that wind farms would have to be constructed on lower priced land. In fact, most studies have found this to be the case (e.g., Hinman, 2011; Hoen, et al, 2009); that is, there is a significant location effect prior to wind farm development.

- McCann has suggested that the Hoen, et al (2009) study indicates negative property value effects from turbine visibility. However, McCann does not grasp the difference between scenic vista (VISTA) and view of turbines (VIEW) in the Hoen, et al (2009) report (see for example, Figures 5 and 6). The correct interpretation is: (1) yes, scenic vista does add

appreciably to a home's value and if this vista was eliminated then there would be a reduction in value (see Figure 5); and (2) the Hoen, et al analysis controls for scenic vista in the analysis of turbine view – exactly the point of the hedonic price method. That is, in the analysis of VIEW the hedonic price method controls for the confounding variable VISTA. Given that control, LBNL finds no impact of turbine view on home sale price. Note that if VISTA was not controlled for then VIEW would be positively related to home sale price, exactly counter to McCann's position.

- McCann has suggested that that pooling data from multiple sites biases the results in favor on statistical insignificance. However, pooling does not necessarily "broaden the standard deviation (McCann's words)," fostering insignificance. It depends on the compatibility of the pooled areas – if the pooled areas are very similar then the standard deviations are actually narrowed. In fact, there is a test (F-test) that allows a researcher to determine whether or not pooling is permissible from a statistical perspective. Hoen, et al conducted the test and pooling was statistically permissible. In the 2009 Hoen, et al study, the standard deviations become smaller with pooling – see Appendix F in the 2009 study which shows that the unrestricted models (essentially the un-pooled model) have larger standard deviations than the restricted models (pooled model). Also, note that the Carter (2010) and Heintzelman/Tuttle (2011) studies (among others) do not pool the data across study areas and come to the exact same conclusion as the 2009 and 2013 Hoen, et al studies – the sale prices of nearby properties are not impacted by wind farms.

- McCann consistently refers to the Heintzelman/Tuttle study as evidence that wind farms negatively impact residential property values. In fact, the study does find negative impacts from wind farms only in the post-announcement/pre-construction period. The paper has many issues, as described below, but the results are consistent with the larger literature. Specifically, a thorough analysis of Heintzelman/Tuttle suggests evidence in the post-announcement/pre-construction period that wind turbines have negative consequences for nearby property values – however, post-construction the effects disappear.

    - Heintzelman/Tuttle remark that audible and visual effects might have a "strong negative impact" on property values, but do not collect much data that actually tests this, when the turbines are operational. Specifically, their dataset spans through 2009, yet two of the six wind facilities were brought online that year, two others were brought online in 2008 (see Table 1 of Heintzelman/Tuttle), and a fifth had not completed construction (see Footnote 11 of Heintzelman/Tuttle). Only in Lewis County do the authors actually test post construction effects with any veracity; that facility (it was actually built in multiple phases) was brought online in 2006. It is therefore important to note that in Lewis County, where the only set of post-construction transaction exists in their data, they fail to find statistically significant results (for the continuous variable – as shown in Table 7, Model 1 - while it is this variable, in the other two counties, on which they base their conclusions).

Relevance of Literature for South Dakota Projects

- None of the previous academic research, nor for that matter, any of the "alternative literature," has included South Dakota wind projects. Therefore, to predict what might occur near South Dakota wind facilities requires the **transfer** of existing research. Some of the literature is not relevant to the South Dakota projects. For example, the Atkinson-Palombo and Hoen (2014) and Lang, et al (2014) were conducted in primarily urban areas of Massachusetts and Rhode Island, respectively. Further, the Massachusetts study was focused on small scale wind facilities. Likewise, Hinman (2010), Carter (2011), Magnussen and Gittell (2012), and Heintzelman and Tuttle (2012) examined single wind farms in very specific locations (note there were three developments studied by Heintzelman and Tuttle). Therefore, these would likely have limited transferability to South Dakota.

- The LBNL studies were constructed with such transferability in mind. That is one of the reasons that wind facilities from across the US were studied and the data pooled into a single analysis. Thus, these studies seem to be the most apropos to the task. But, it also must be the case that the range of wind facilities studied by LBNL include the type of South Dakota counties in which the proposed facilities are to be constructed. To examine this question in more detail consider Table 1 below, in which some common socioeconomic measures are listed. Population, population per square mile, and median age are from 2014, whereas median income and median home value are 2013 levels. The table include three panels, with the upper panel listing the counties in the 2009 LBNL study, the middle panel the counties in the 2013 LBNL study, and the bottom panel the counties in South Dakota where the proposed wind facilities are to be built, respectively.

- In general, the South Dakota counties seem to have lower average population/mi^2, median income, and median home value than the average county in either the 2009 or 2013 LBNL studies. But the South Dakota counties look very much like their Minnesota counterparts, especially Cottonwood County and Jackson County. Franklin and Sac counties in Iowa are also quite similar to the South Dakota counties. So the range of counties studied in the LBNL includes counties like those in South Dakota.

- Given this information about the types of facilities planned and the previous research on like counties, we would be confident that the LBNL studies would be a reasonable source for a benefit transfer (or damage transfer) effort to South Dakota. This leads to the overall conclusion that, **the planned wind projects in South Dakota will not significantly reduce the sales prices of properties in the neighborhood of the wind facilities.**

Table 1
Comparative Data

County	State	Population	Population/mi^2	Median Age	Median Income	Median Home Value
Buena Vista	IA	20,578	36	37	46,469	99,744
Lee	IL	34,735	48	42	51,682	140,291
Livingston	IL	37,903	36	40	55,287	102,523
Madison	NY	72,369	110	39	52,300	135,300
Oneida	NY	232,871	192	40	43,702	113,600
Custer	OK	29,500	30	31	45,179	114,228
Umatilla	OR	76,705	24	35	48,514	138,600
Somerset	PA	76,218	71	44	43,429	103,900
Wayne	PA	51,401	70	45	47,932	179,354
Howard	TX	36,651	41	38	47,906	67,485
Benton	WA	184,486	109	35	48,997	176,500
Walla Walla	WA	58,844	47	36	45,875	186,784
Door	WI	27,766	58	49	50,586	187,484
Kewaunee	WI	20,444	60	42	52,929	145,344
Average	**LBNL 2009**	**68,605**	**66.6**	**39.5**	**$49,342**	**$132,510**
Carroll	IA	20,562	36	42	50,074	107,911
Floyd	IA	16,077	32	43	44,152	92,087
Franklin	IA	10,436	18	42	48,715	89,330
Sac	IA	10,035	17	46	48,451	81,367
DeKalb	IL	105,462	166	29	52,867	160,600
Livingston	IL	37,903	36	40	55,287	102,523
McLean	IL	174,06	147	32	61,846	160,300
Cottonwood	MN	11,633	18	44	45,949	83,197
Freeborn	MN	30,840	44	44	46,698	99,683
Jackson	MN	10,629	15	44	52,428	93,644
Martin	MN	20,220	29	45	51,865	98,341
Atlantic	NJ	275,209	491	39	52,127	218,600
Clinton	NY	81,632	79	39	43,892	121,200
Franklin	NY	51,262	31	39	45,580	93,529
Herkimer	NY	63,744	45	42	43,754	89,098
Lewis	NY	27,220	21	40	47,990	103,257
Madison	NY	72,369	110	39	52,300	135,300
Steuben	NY	98,394	71	41	47,046	90,900
Wyoming	NY	41,188	69	40	50,949	96,515
Paulding	OH	18,989	46	40	44,650	89,619
Wood	OH	129,590	210	35	51,680	147,300
Custer	OK	29,500	30	31	45,179	114,228
Grady	OK	53,854	49	38	50,677	111,956
Fayette	PA	134,086	170	43	38,903	89,100
Somerset	PA	76,218	71	44	43,429	103,900
Wayne	PA	51,401	70	45	47,932	179,354
Kittitas	WA	42,522	19	31	43,849	234,150
Average	**LBNL 2013**	**62,766**	**79.3**	**39.9**	**$48,454**	**$118,037**
Clark	SD	3,645	4	45	48,511	72,127
Codington	SD	27,938	41	37	46,361	140,909
Grant	SD	7,241	11	45	48,354	105,054
Average	**SD**	**12,941**	**18.7**	**42.3**	**$47,742**	**$106,030**

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- Ph.D. in Economics from University of New Mexico, 1979
- Field of expertise is environmental, natural resource, and energy economics
- Emeritus Professor, Department of Economics at San Diego State University
- Nationally known expert in the valuation of environmental commodities
- Thirty-five plus years of experience in both university and government service
- Extensive experience integrating environmental and energy related matters into decision making at the state and federal level
- Published numerous research articles in professional journals such as *American Economic Review, Journal of Political Economy, Journal of Environmental Economics and Management, Land Economics, Natural Resources Journal, Journal of Urban Economics, Economic Inquiry, Journal of Sports Economics, and Journal of Human Resources*
- Principal investigator on projects funded by entities such as the California Air Resources Board, California Energy Commission, U.S. Environmental Protection Agency, U.S. Geological Survey, the South Coast Air Quality Management District, and the National Science Foundation

APPENDIX A

Response to Mr. Albert Wilson and Industrial Wind Action Group Critiques

ERNEST ORLANDO LAWRENCE BERKELEY

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Response to Mr. Albert Wilson and Industrial Wind Action Group Critiques

Ryan Wiser, Ben Hoen, Peter Cappers, Mark Thayer, Gautam Sethi

March 8, 2010[1]

Introduction

On November 20, 2009, the Industrial Wind Action Group (IWAG) posted an editorial that, in part, lists a number of concerns about Berkeley Lab's efforts to investigate the presence of residential property value impacts associated with U.S. wind power facilities.[2] That editorial follows from more-extensive review comments provided on September 11, 2009 by the Industrial Wind Action Group.[3] The more extensive comments were provided during the external review of the draft Berkeley Lab report, and were one of roughly 20 sets of external review comments received by stakeholders and experts at that time. All of these comments were considered during revisions to the draft report, culminating in the final analysis and report issued on December 2, 2009. More recently, Mr. Albert Wilson posted his critique of the report, which in many respects is similar to that of the IWAG postings.[4]

Though the final Berkeley Lab study largely speaks for itself, this memorandum offers a brief response to the specific comments enumerated in these critiques.[5] Before responding to the specific comments offered, however, one important observation should be made: the Berkeley Lab report does not offer definitive proof that wind projects, under all circumstances, will never impact residential property values. Therefore, as the IWAG correctly claims, the results of this work should not be summarized as such. Rather, the Berkeley Lab work, as discussed extensively in the final report, finds no persuasive evidence of any consistent, measurable, and statistically significant effect given the sample of home sales transactions evaluated. As noted on several occasions in the report, although the analysis cannot dismiss the possibility that

[1] This memo is a revised version of the "Response to Industrial Wind Action Group Critiques" issued on December 2, 2009.
[2] "False conclusions based on flawed real estate studies," http://www.windaction.org/faqs/24176.
[3] "Hedonic analysis of the impact of wind power projects on residential property values in the United States," http://www.windaction.org/documents/24178.
[4] "Wind Farms, Residential Property Values and Rubber Rulers," http://www.arwilson.com/pdf/newpdfs/WindFarmsResidentialPropertyValuesandRubberRulers.pdf .
[5] The IWAG editorial posted on November 20th makes a number of additional claims, suggesting that the authors of the study were predisposed to a preferred outcome, had no interest in conducting a legitimate study, and had no interest in releasing a final report. These claims are baseless, and are therefore not addressed here.

individual homes or small numbers of homes have been or could be negatively impacted, the extensive research finds that, if these impacts do exist, they are either too small and/or too infrequent to result in any statistically observable impact within the sample of nearly 7,500 home sales transactions evaluated.

Mr. Wilson and IWAG Comment: Regression analysis is not in accordance with the International Association of Assessing Officers' (IAAO) established methods

Both the IWAG and Mr. Wilson claim that the methods employed by the Berkeley Lab study are not in accordance with the established methods of the International Association of Assessing Officers' (IAAO).

This claim encompasses two issues, both of which will be addressed below: 1) The IAAO standards for estimating the selling prices of homes are not met by the analysis contained in the report, and, 2) that an hedonic analysis is not the appropriate model to use for evaluating effects environmental contamination on property values.

Response to the IAAO standards for estimating the selling prices of homes are not met by the analysis contained in the report: The methods of the IAAO are irrelevant for estimating a hedonic pricing model of the nature used in the Berkeley Lab report.

As noted in the final report, the Berkeley Lab research is not designed to assess, appraise or predict selling prices of properties (i.e., an "appraisal model" used to establish an estimate of the market value of a home at a specified point in time). Rather, the hedonic models as used in the report are designed to estimate the marginal contribution of individual house or community characteristics to sales prices. The distinction is that an appraisal model, as governed by the IAAO standards, requires a very accurate final prediction of price, because it is this "selling price" which is the purpose of the model. Alternatively, a hedonic model, as used in the LBNL report, is not particularly concerned if a final selling price is accurately predicted, but rather, that the individual contribution of one or more characteristics to that selling prices are accurately estimated.

Moreover, predicting selling prices accurately is inherently difficult because of the heterogeneous qualities of markets, buyers and sellers. For that reason, appraisal models often use relatively small localized data sets (i.e., “comps”) pertaining to nearby properties that sold over a short period of time and a limited number of explanatory variables. On the other hand, a hedonic model relies upon large data sets, with a sizable number of explanatory variables, potentially occurring over a long time period. For these reasons, the datasets, resulting models are quite different and therefore standards for one type are not necessarily applicable to the other.

As an example, the specific statistic that both Mr. Wilson and the IWAG cite, as important to the IAAO standards, is the R^2. This statistic is a measure of "goodness of fit" or, in other words, how well the model estimates final selling prices. A model that perfectly predicts selling prices will have an R^2 of 1.00, indicating there is no difference between actual selling prices, and those predicted by the model. As discussed above, the ability of the model to predict final selling prices is somewhat irrelevant to the task intended in the LBNL report, but not so for appraisal or

assessing models. It follows that for IAAO standards, which govern the prediction of selling prices, an R^2 less than 0.90 to 0.95 is considered unacceptable. (It is for this reason that the data used for these models is often homogeneous (i.e., similar types of homes) with limited spatial and temporal diversity.) Alternatively, for hedonic models as thay are used in the report, an R^2 of 0.70 or lower is not considered unusual, because the data is intentionally heterogeneous with a wide spatial and temporal diversity. More important to the research is that the estimates for the marginal contribution to sale prices are accurate. Nonetheless, an R^2 is used in studies similar to that of the LBNL report to gauge appropriateness of the model variables. To that end the relatively high R^2 (~ 0.77) found in the Berkeley Lab analysis - as compared to other cross-sectional analyses - substantiates the appropriateness of the variables used.

Response to an hedonic analysis is not the appropriate model to use for evaluating environmental contamination: The hedonic method is not the only method to estimate the marginal impacts that environmental dis-amenities (and amenities) have on selling prices, but is most definitely an accepted one, if not the preferred method when adequate data is available. [6]

As discussed in Section 2.1 of the final report, the hedonic pricing method is well established and widely used in the economics and real estate literature for evaluating the marginal impacts of environmental amenities and disamenities on housing prices. An extensive literature that began with the seminal works of Rosen (1974) and Freeman (1979) has developed outlining it use. The Berkeley Lab report clearly documents the history and use of the hedonic pricing model, its appropriateness for exploring the possible impact of wind projects on property values, and how the multiple statistical models employed in the Berkeley Lab research relate to the broader economics and real estate literature. For instance, the literature is replete with analysis conducted using similar methods (see for example the reviews Kroll and Priestley 1992; Farber 1998; McCann 1999; Bateman et al. 2001; Boyle and Kiel 2001; Jackson 2001; Nelson 2004; Ready and Abdalla 2005; Simons and Saginor 2006; Simons 2006b; Leonard et al. 2008).

IWAG Comment: Study neglects to explain the risks of employing Hedonic analysis

The IWAG claims that the study neglects to explain the risks of employing hedonic analysis, that causal conclusions drawn about a dataset when utilizing hedonic analysis are often unsupportable, and that the literature is highly critical or even dismissive of the hedonic method. Further, the IWAG notes that, "a major limitation of observational data is that they often do not provide adequate information about cause-and-effect relationships" (i.e., correlation does not necessarily imply causation).

Response: The final report offers a review of the hedonic literature, and provides a number of citations (some noted above) to which a reader can go for a more extensive review of the history and use of this method. As discussed in the report, though all methods have limitations, the hedonic pricing method is well established. The literature is neither "highly critical" nor "dismissive" of the method; if anything, the opposite is true (see footnote 6 below). Moreover,

[6] For example, see the two articles by Thomas Jackson, MAI, who was former member (2001 and 2002) of the six-person Uniform Standards of Professional Appraisal Practice (USPAP) board, "Methods and Techniques for Contaminated Property Valuation" (2003) and "Evaluating Environmental Stigma with Multiple Regression Analysis" (2005). Hedonic pricing models are a form of "Multiple regression analysis".

as discussed in the Berkeley Lab report, there is an extensive literature that has steadily improved the method, and the method is regularly used by both economics and real estate experts to evaluate the marginal impacts of environmental amenities and disamenities on housing prices. The hedonic method is the most appropriate approach to evaluate the question at hand: whether wind energy facilities have any demonstrable and widespread effect on home prices.

Moreover, the study employs not one, but eight different hedonic models, as well as both repeat sales and sales volume models, all of which provide tests for the robustness of the results. The consistency of the results of these various analyses provides confidence in the final results discussed in the report and, in combination with the extensive data collection effort, produces the most comprehensive and data-rich analysis to date in the U.S. or abroad on the possible impacts of wind projects on property values.

The IWAG is correct that hedonic analysis focuses on correlations, and that correlation does not necessarily imply causation. At the same time, the Berkeley Lab analysis finds no correlation between wind facilities and home sales prices. Because of this finding, and because of the care taken by Berkeley Lab in the measurement of the variables of interest, the difference between correlation and causation is moot: with no correlation there can be no causation.

IWAG Comment: Background review of other studies [was not thorough]

The IWAG notes that much of the previous work that has investigated the potential impact of wind projects on property values has limitations, rendering the results of some of this literature misleading or invalid.

Response: The Berkeley Lab report authors agree that there are a number of limitations to the previous work, a point made clearly in Section 2.2 of the final report. Specifically, a large number of the previous studies investigating property value effects surrounding wind facilities have not been peer reviewed, and suffer from a variety of substantive limitations (e.g., lack of reliance on market data, small sample sizes, overly simplistic statistical techniques, and unreported statistical significance). As discussed extensively in the report, the methods applied by Berkeley Lab were specifically intended to overcome many of the limitations of this previous literature. As a result, the Berkeley Lab research is the most reliable, comprehensive, and data-rich analysis to date on the possible impacts of wind projects on property values.

Mr. Wilson and IWAG Comment: No clear evidence the data used was checked for accuracy

The IWAG argues that there is no evidence that the data used in the model were checked for accuracy, and that non-valid sales transactions (i.e., "dirty sales") might have been included in the final data set. Similarly, Mr. Wilson argues that the results can be adversely affected by outliers and influential observations.

Response: As noted in the final report in Section 3.2.1, only "valid" sales are included in the dataset; as discussed, the validity of those transactions is determined as follows:

"Validity was determined by each individual county data provider. A sale that is considered "valid" for county purposes would normally meet the minimum requirements of being arm's length; being a transfer of all rights and warrants associated with the real estate; containing an insignificant amount of personal property so as not to affect the price; demonstrating that neither party in the sale acting under duress or coercion; not being the result of a liquidation of assets or any other auction, a mortgage foreclosure, a tax sale, or a quit claim; and being appropriate for use in calculating the sales price to assessed value ratios that are reported to the state. Due to the formal requirements associated with this calculation, "validity" is often defined by a state's Department of Revenue…"

Though the study therefore relies, to some degree, on individual county-level data providers to help ensure the validity of the resulting sales data, it is highly unlikely that the many kinds of sales of concern to the IWAG are included in the final data set. Moreover, to provide greater certainty to that finding, the authors also excluded transactions that had certain characteristics that might place them in doubt (e.g., transactions that occurred within six months of a previous sale of the same home, and transactions that produced a statistical residual greater than six standard deviations from the mean of all residuals).[7] In addition (addressing Mr. Wilson's claim), tests were conducted to evaluate whether certain additional transactions that might be classified as outliers and/or influencers (i.e., dirty sales) might be inappropriately influencing the results. A thorough inspection of this group of outliers and/or influencers was conducted to help ensure that the dataset met the requirements for a hedonic model and that the results are not inappropriately influenced by suspect data. These procedures are documented clearly in the final report in Appendix G.

Mr. Wilson and IWAG Comment: No information in the study confirms whether the model was tested or calibrated using actual sales data

Both Mr. Wilson and the IWAG claim that, according to IAAO, when a model is specified an iterative process of calibrating the model using alternative data sets is necessary to test and fine tune the model's coefficients. The IWAG also notes that thousands of possible models can be applied in a given situation, and argues that the authors should explain what process was followed in the Berkeley Lab analysis.

Response: As stated above, the IAAO standards are not relevant for the hedonic pricing models used in the Berkeley Lab research: the research is not designed to appraise properties (i.e., predict selling prices) so calibration to actual sales data is not relevant.

The research does, however, follow typical research protocols for estimating and interpreting a hedonic price function. As noted clearly and repeatedly in the body of the report and in the appendices, a variety of hedonic models were tested, from which the final models were selected.

[7] The rationale for these restrictions is provided in the full Berkeley Lab report. As noted in Section 3.2.1, these excluded transactions total 39, 32 of which occurred following construction, two were for homes that had a view of the turbines (both minor), and one was for a home located inside of one mile. Although the sale that involved a home located inside of one mile was removed, a number of other homes from the same neighborhood, also inside of one mile, were included in the final dataset.

The process of selecting the final eight hedonic models is discussed throughout the document, and the results of alternative model specifications are discussed in a number of footnotes and in the appendices. The performance of the final models are reported (e.g., adjusted R^2 and other statistics), and are consistent with hedonic analyses conducted by others. Moreover, the results are benchmarked to the broader hedonic literature as discussed in the following passage from Section 4.3:

> *"To benchmark the results against those of other practitioners the research by Sirmans et al. (2005a; 2005b) was consulted. They conducted a meta-analysis of 64 hedonic studies carried out in multiple locations in the U.S. during multiple time periods, and investigated the coefficients of ten commonly used characteristics, seven of which were included in the model. The similarities between their mean coefficients (i.e., the average across all 64 studies) and those estimated in the present Base Model are striking."*

The report then compares each coefficient in the base hedonic model to those in Sirmans et al. and finds, in conclusion,

> *"As a group, the Base Model estimates differ from Sirmans et al. estimates in all cases by no more than a third of the Sirmans et al. mean estimate's standard deviation. This, taken with the relatively high adjusted R^2 of the…model [0.77], demonstrates the appropriateness of the model's specification."*

Mr. Wilson Comment: The estimated hedonic coefficients must be tested to determine if they accurately and only represent the explanatory variables and they represent an economic impact

Mr. Wilson claims that the coefficients estimated in the model must be tested to determine if they accurately and only represent the explanatory variables (i.e., are they "biased") and that even if they are not statistically significant that they might represent and "economically" significant effect.

Response: This claim essentially puts forward that the authors should consider effects worth discussing the importance of, even if they are not statistically identifiable (i.e., less than the margin of error). There is merit in this claim, in that the numbers of data can influence the statistical significance of a variable, even if the estimated effect is accurate. Therefore, for purposes of this discussion the variables of interest can be broken into two groups, those that were identified as statistically significant and those that were not.

Statistically significant variables: All statistically significant variables were discussed at length in the report. For variables to be considered a valid measurement of an effect, they needed to be significant across many models, and, moreover, be intuitive. For example, a variable indicating a positive effect on selling price despite the assumption of a negative effect, or one that contradicts the effects found in the same model by other similar variables, would not be given much weight in the discussion.

Statistically insignificant variables: In all cases a statistically insignificant variable is smaller than the margin of error. It is possible that the margins of error, though, are so large, as to obscure a potentially "economically" significant effect. That notwithstanding, putting much weight on a variable of this type is risky for the practitioner, for statistically speaking, the analysis cannot determine reliably if the effect is above or below zero - a difference that would also affect the determination as to whether it is "economically" significant. Nonetheless, the report makes every effort to flush out these potentialities. For instance, when non-statistically significant effects were found to be near -5% for homes within one mile and that sold after the wind facilities were constructed, extensive analysis was conducted to determine if those effects should be considered accurate. The report conducted no less than 4 alternative models investigating this issue, only to find that effects that pre-existed the wind facilities announcement and construction, likely were driving these adverse effects, and therefore less confidence could be placed in them.

Finally, as regards bias in the explanatory variables, extensive efforts were made to explore such biases, and offer alternative interpretations of results taking into account such biases. To that end, robustness tests are conducted for alternative explanatory variables, alternative samples, outliers/influential observations, pooling, etc. In all cases the results pertaining to the focus variables (i.e., the estimated coefficients on variables of interest) were robust.

Mr. Wilson and IWAG Comment: The data set is not homogeneous; data is drawn from across the country

Mr. Wilson and the IWAG claim that lack of homogeneity in the final data set is fundamentally problematic, and argues that a basic assumption of a regression analysis is that the data are reasonably homogenous (i.e., that the homes included in the dataset are reasonably similar in characteristics, amenities, etc.). The IWAG also argues that applying the same weight to property characteristics (e.g., fireplaces) across the entire nine-state region is inappropriate. Finally, the IWAG claims that the model does not allow one to understand how the age of the home impacts sales prices or, for that matter, square footage, number of baths, etc.

Response: Overall, Mr. Wilson and the IWAG concerns encompass three different themes: (1) the data are pooled from different study areas across the country, (2) individual home characteristics have a significant amount of variation (e.g., price of homes and the age of homes), and (3) the estimated coefficients are not allowed to vary across study areas but rather are estimated across the entire dataset. Each concern is addressed in turn.

- Data are pooled from different study areas across the country: As discussed in detail in the Appendix F, models specific to individual study areas were extensively tested and evaluated. These models, however, were found to be less parsimonious than the final models and exhibited divergent and spurious coefficients, as well as large standard errors, for the variables of interest, presumably because of the small number of home sales in each of the individual study areas near the wind turbines. As a result of this analysis, a pooled model is used. The details of this process and the rationale for selecting a pooled model are clearly documented in the final report. Moreover, allowing study area influences to be estimated at a micro-level, as discussed in Appendix F, does not impact the variables of interest.

- Individual variables have a significant amount of variation: Though the IWAG argues that homogeneity in the dataset is a prerequisite for a regression analysis, the very purpose of a hedonic model is to control for heterogeneity in the data to evaluate the marginal impact of varying house characteristics. In general, then, variation in housing characteristics within the data set is valuable as long as the variation in the independent variables explains the variation in the dependent variable, and there are no omitted variable biases. The relatively high adjusted R^2 (~ 0.77) found in the Berkeley Lab study - which is a cross-sectional property value analysis - substantiates the appropriateness of the data and model used. Further, as discussed in the report and above, coefficient estimates for a variety of property characteristics are consistent with those of other practitioners using similar methods. Finally, as discussed above and in Appendix G in the report, extensive testing regarding the impact of outliers and influential observations is conducted, ensuring that individual questionable sales transactions are not unduly influencing results of the study.

- The estimated coefficients are not allowed to vary across study areas: As addressed in the first bullet above (and in Appendix F in the report), alternative hedonic models were tested in which all variables were interacted with dummy variables for the individual study areas; in these models, the value of a fireplace in one study area, for example, is allowed to differ from the value in other study areas. Appendix F clearly reports how the final models were selected from multiple alternative specifications. Importantly, the focus variables, namely the effect of proximity and views of wind facilities, are robust to the inclusion/exclusion of these interactions. As such, including these interactions in the model does not impact the results of the Berkeley Lab analysis.

With respect to understanding how the age of the home impacts sales prices or, for that matter, square footage, number of baths, etc., this information is clearly provided in the regression results presented in Section 4.2 (for the base model) and in Appendix H (for the other models).

Mr. Wilson and IWAG Comment: The data set omits property characteristics

Both Mr. Wilson and the IWAG claim that a variety of important property characteristics were omitted from the analysis, noting specifically the omission of the number of bedrooms. If, as Mr. Wilson correctly contends, variables omitted from the model are inappropriately influencing results, one is likely to see coefficients that represent the combined effects of the focus variable and the omitted variable.

Response: The protocols for estimating a hedonic price function, as discussed in Appendix G, are clear: including too many independent variables that measure the same basic thing (e.g., square footage of living area and total rooms) can produce harmful collinearity in a regression model. Further, testing multiple forms of the model, to explore possible omitted variable bias and test robustness of results is crucial.

Therefore, to address collinearity, the accepted method for hedonic analysis is therefore not to include all possible independent variables, but to instead specify a relatively parsimonious model

that contains key variables that represent the various aspects of a home (e.g., size as measured by square footage; quality as measured by condition and the number of specialty items such as fireplaces, bathrooms, etc.; neighborhood influences such as school quality, etc.) and then to test whether the inclusion/exclusion of specific independent variables significantly impacts the coefficients of the focus variables. This was the protocol used in this study, as discussed in Appendix F and G, and is entirely consistent with the broader hedonic literature. Similarly, to address omitted variable bias (i.e., that the variables are measuring more than one characteristic), efforts should be made to construct many model specifications, with alternative datasets etc to test the reliability of the results. The results for the LBNL focus variables were found to be robust to the inclusion/exclusion of various potential sets of independent variables (including the number of bedrooms), and a variety of forms and datasets.

Mr. Wilson and IWAG Comment: Model is not peer-reviewed; data withheld from independent reviewers

Both Mr. Wilson and the IWAG claim that the Berkeley Lab report was not "peer reviewed" because the authors "refused to release the data set to reviewers."[8]

Response: Berkeley Lab conducted a thorough external review of the draft report, responded to follow-up inquiries upon request, and provided a full set of results with the draft report, all of which are customary for this type of report. The comments received during that process from roughly 20 external reviewers made up of experts and stakeholders were considered in the preparation of the final report.

Moreover, the authors plan to submit a shortened version of the report for consideration in a peer-reviewed academic journal. At that time, the authors hope to be able to release the dataset used in the analysis so that others can further verify the results. A number of confidentiality arrangements were required to obtain the data used in this report from the individual study areas, however, and those arrangements will need to be revisited and potentially re-negotiated before the final data set can be made available.

Mr. Wilson Comment: Dataset has too few observations with a view of the turbines and/or in close proximity to the turbines.

Mr. Wilson claims that the Berkeley Lab report dataset, despite being 7,500 transactions, has too few near the turbines, and/or with a view of the turbines to reliably estimate effects.

Response: Consider homes with a view (or near the turbines) to be the treatment group and the homes without the view (or further away) to be the control group. This comment can be taken in one of two ways: (1) the control group is too large; or (2) the treatment group is too small. With regard to the former, the size of the control group cannot be too large when determining the

[8] Mr. Wilson also contends that the peer review process for journals, "does not, in any meaningful way, address the validity of the underlying work". Admittedly the journal review process is imperfect, but to imply that it is ignorant of the validity of the underlying work is "throwing the baby out with the bath water". The peer review process and ultimate publishing of research allows ample opportunity for methods and results to be challenged (e.g., Assorted 2006; Wilson 2006).

impact of the treatment (note it could be too small but this is not a consideration in the Report). And a large control group is required to estimate the other parameters in the model (effect of living area, bathrooms, house quality, etc.). With regard to the latter, if the size the treatment group is too small then the research could be affected by small sample size issues (e.g., spurious correlations, results driven by outliers, etc.). This is one reason why individual area data sets were pooled and the Report included extensive analysis of outliers and influential observations. The results pertaining to the focus variables were unaffected by either pooling or outliers/influential observations.

Conclusion

Although the IWAG's concerns are extensive, the majority of those concerns are not consistent with the extensive literature on the hedonic pricing method and its use in investigating the possible impact of amenities and disamenities on property values. Moreover, as discussed above, the authors believe that any relevant concerns expressed by the IWAG are already adequately addressed in the final report. The hedonic pricing model, as used in this study, is the appropriate method to address the question whether views of and proximity to wind facilities affect residential sales prices. Further, many of the limitations of the previous literature (e.g., small sample size, unreported statistical significance) are directly addressed by the Berkeley Lab analysis. The efforts made to benchmark the results to other literature and to test the robustness of the report's findings further substantiate the approach and results of the research. Therefore, although all analysis has limitations and additional research is warranted, the authors maintain that the Berkeley Lab work is the most reliable, comprehensive, and data-rich research effort to date in the U.S. or abroad on the possible impacts of wind projects on property values.

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APPENDIX B

Summary of Estimated Values for Various Home Location Attributes

Background

The summary of relative values is based on the premise that proximity to and views of environmental (dis)-amenities can impact nearby residential property values and that these values can be uncovered using the hedonic price method. There are two primary conclusions that can be drawn from table B.1. First, a wide variety of location specific influences impact housing prices. Second, with the exception of beachfront or direct water access, the impact of a specific variable is relatively small, usually less than 10%. For example, location inside an earthquake special studies zone (an area of active surface faulting) causes a reduction in house price of between 3.3 and 5.6 percent. This further suggests that speculative estimates of greater than 40% reductions in home value for proximity to an operational wind farm should be viewed with extreme caution.

Table B.1
Relative Values of Various Location Variables

Location Characteristics				
Beachfront	Atkinson-Palombo and Hoen (2014)	Massachusetts	25.90%	Within 500 feet
Direct Water Access	Thayer, et al (1992)	Baltimore, MD	25.30%	Water or Pier Access
School Quality	Brookshire, et al (1982)	Los Angeles, CA	0.20%	Standardized Scores
Groundwater Post-Remediation	Case, et al (2006)	Scottsdale and Tempe, AZ	No difference	Previously contaminated
Lead Smelter	Dale, et al (1999)	Dallas, TX	-0.8% to -4%	Within a mile
Landfill – Low Volume	Ready (2005)	Assorted	0% to -3%	Adjacent to landfill
Foreclosures	Lin, Rosenblatt, and Yao (2009)	Chicago, IL	-1.2% to -1.7%	0.9 kilometers
Landfill	Thayer, et al (1992)	Baltimore, MD	-1.3% to -5%	Within a mile
Distance to Beach	Brookshire, et al (1982)	Los Angeles, CA	-1.40%	Per Mile from Beach
Total Suspended Particulates	Brookshire, et al (1982)	Los Angeles, CA	-1.60%	1000 ug/m^3
Crematory	Agee and Crocker (2008)	Rawlings, WY	-2% to -16%	Within a mile
Power Plant	Davis (2008)	Assorted	-3% to -5%	Within 2 miles
Earthquake Special Studies Zone	Brookshire, et al (1985)	Los Angeles and San Francisco	-3.3% to -5.6%	Inside Zone
Sex Offender	Linden and Rockoff, 2006	North Carolina	-4%	One-tenth mile
Superfund	Gayer, et al (2000)	Grand Rapids, MI	-4% to -6%	Within a mile
Highways	Atkinson-Palombo and Hoen (2014)	Massachusetts	-5.30%	Within 500 feet
Landfill	Reichert, et al (1992)	Cleveland, OH	-5% to -7%	Within a few blocks
Groundwater Pre-Remediation	Case, et al (2006)	Scottsdale and Tempe, AZ	-7%	Currently Contaminated
Industrial – Superfund	Carroll, et al (1996)	Henderson, NV	-7%	Within a mile
Transmission Lines	Atkinson-Palombo and Hoen (2014)	Massachusetts	-9.30%	Within 500 feet
Waste Transfer Station	Eshet, et al (2007)	Israel	-12%	Within a mile
Landfill	Atkinson-Palombo and Hoen (2014)	Massachusetts	-12.20%	Within one-half mile
Landfill – High Volume	Ready (2005)	Assorted	-13%	Adjacent to landfill
Superfund	Kiel and Zabel (2001)	Woburn, MA	-15%	Within a mile