

Critique of  
*The Impact of Wind Power Projects on Residential Property Values in  
the United States: A Multi-Site Hedonic Analysis*

Authors: Hoen et al

By Wayne Gulden  
[wayne@windfarmrealities.org](mailto:wayne@windfarmrealities.org)

February 16, 2010

## Introduction

The issue of wind turbines and their effect upon nearby property values has long been a contentious one, and for good reason. We generally accept the “wisdom of the market”, and if wind turbines are as disruptive as opponents claim, surely this would show up in market prices of nearby properties. Opponents, politicians and wind developers can make all sorts of statements about noise, flicker, birds and so on, but talk is cheap. House prices, on the other hand, can be quite dear, and there’s no easy or cheap way to hide the effect of wind turbines on house prices if in fact there is an effect. Plus house prices can serve as a single and quantitative proxy for all the effects that wind turbines may have on the neighbors.

Given the long history of the real estate industry figuring out house prices (commonly called “comps”) you’d think this issue would be easily settled. Unfortunately, it is possible to arrange the data in these studies to suit the sponsor – as Mark Twain famously observed, “figures don’t lie, but liars figure”. But couldn’t one just take the prices of houses sold “in the area” before and after a project went in? But how big should “the area” be? And if there’s only a small number of sales – these are, after all, generally remote areas – what conclusions can you draw?

For the wind industry and its allies in government and academic circles, persuasive studies showing no effect would go a long way to quiet the protests of the neighbors and make wind projects easier, quicker and cheaper to install. Almost needless to say, they have been working on such studies for a number of years. A major one was the REPP study (aka Sterzinger et al), and which is available at <http://windfarmrealities.org/wfr-docs/reppreport.pdf> . It was not persuasive (except among wind proponents), having used a large and undefined area in which most homes were so far from the project that any effect would be minimal. In fact Hoen was one of the REPP study’s most severe critics. But the REPP study did reveal the underlying argument the wind industry could use to try to convince the willing and the gullible. They justified the large study area by asserting the main problem with turbines was *how they looked*. So if you could just see them (and you can see them for miles) they ought to affect the prices and since there was no measureable effect on prices there must be

no problems whatever with the turbines. Nice logic, if you can convince someone to accept it, and many politicians and reporters have done so.

This theme of the people objecting to wind projects mainly because of how they look is mentioned prominently in wind industry literature as the main reason people object to them. Never mind the noise, flicker, sleep problems and so on that are much more important for the actual close-in neighbors. The only place where serious visual objections are raised is where the scenery has a special value, like shorelines. Unfortunately, no property value study has ever been done specifically on projects in high-scenic-value locations. There's just not enough data yet – for example in this study only 117 properties, or 2%, had “premium vistas”.

Regardless of what the wind industry asserts, the serious concerns for property values come from people who think they might be able to *hear* or *feel* the turbines enough so they cannot escape the noise and vibration even when they are just trying to enjoy their property, and especially when they are trying to go to sleep. For a home affected by this sort of problem the reduction in value might be very large indeed, certainly into double digits and in the worst cases approaching 100%. This is what home owners really fear.

To simplify it, there are three main ways to analyze house prices, in decreasing accuracy.

First, you could study houses within audible distance (i.e. one mile) that sold (or perhaps independently appraised) fairly recently before the project was known about and then sold after the project went in. As long as the sales are “arms-length” and the proper adjustments made for area house price trends, this is the best indication of property value changes.

Second, you could study just the house prices within audible distance of a turbine and compare them with similar houses (aka “comps”) further away, like 10 miles. This technique is commonly used in the Real Estate industry to estimate property values.

Third, you could use regression analysis. You start by taking all the sales within a certain distance of a wind project (5 miles is typical) and assign a series of descriptors to each house within that group – things like size of the house, number of bathrooms, distance from the wind project and so on. You then look for correlations between the different descriptors and the price, trying to assign the contribution of each. With enough computer processing you can assign the effect of each of these on the final price.

The Hoen study, published in December 2009, is the latest effort to analyze this issue and uses the third and weakest of these techniques, regression analysis. I go into more details later, of course, but in summary he found no “statistically significant” effect of turbines on house prices. Unfortunately this study has a number of significant, and in

my opinion fatal problems. If you get to the bottom I've included some critiques from others that come to the same conclusions, certainly more authoritatively than I.

## The Author

The primary author of the study was Ben Hoen, and his career warrants a brief but skippable section. This is not Mr. Hoen's first study in property values around wind projects. In 2006 he completed a master's thesis that looked at the impact of the Fenner, NY wind turbines on surrounding property values. His thesis can be found at: <http://windfarmrealities.org/wfr-docs/hoen-fenner-2006.pdf> . A condensed version, along with a critique, is at: <http://www.windaction.org/documents/3236> . That study concentrated on the relation of the visual aspects of the turbines with house prices and found no evidence of any connection. However, a close reading of that study reveals some problems. First is the acceptance of the "how they look" theme put out by the wind industry lobbyists. Second is the small number of sales inside of one mile – out of 280 sales, only about 8 were inside of that distance (the closest was 0.75 miles), and the average distance was 3.5 miles. There's a picture of the data points at <http://windfarmrealities.org/wfr-docs/hoen-fenner-map.jpg> . Third, while he didn't find any statistically significant evidence of an effect (and with such a small sample of the important sales, how could he?) within Fenner Township, he did find that the Township as a whole had lost some 8% of its house values relative to neighboring townships. He went into overtime to explain away this elephant in the room. I doubt he was very convincing to any disinterested party, but certainly he established whose interests he wanted to serve early on.

From windaction.org,

"Within months of obtaining his masters, Hoen and Wiser teamed up, and since June 2007 Hoen has been broadcasting the results of this latest study even though no data or information on the study was available for others to read and challenge. In the two years leading up to the December 2 [2009, this study] release, Hoen distributed his findings to largely friendly crowds and those more interested in the outcome of his study than the legitimacy of his methodology."

It seems at least unprofessional to discuss your findings in front of those with a financial stake in the outcome before publishing the findings, but it is consistent with his own personal business plan he previously revealed at Fenner. The slides from an early presentation can be found at:

<http://windfarmrealities.org/wfr-docs/hoen-presentation.pdf> .

## Overview of the Study

This study was funded by the U.S. DOE under a government contract at the Berkeley National Laboratory. Berkeley is a leading world center of scientific achievement, and gets its money from the Department of Energy. It would be sensible to keep in mind

that the Department of Energy has a wind program that “is working to improve wind technology and increase the use of wind energy in the U.S.” The study is 164 pages long and can be found at <http://windfarmrealities.org/wfr-docs/hoen-property-values.pdf>, with the body of the report consisting of 75 fairly densely-written pages. Upon a casual reading the study is quite impressive, full of charts and formulae, and Hoen seems to be careful in his analysis. The devil’s in the details.

This study uses the third technique I listed from above - regression analysis. While it is principally concerned with Scenic and Area “stigmas” it does include a “Nuisance” stigma which hopefully promises to answer the issue of the effects on the property values of those neighbors within a mile of the projects, and who have the most to lose. I don’t much value the Scenic and Area metrics as explained above, so my comments will concentrate on the Nuisance metrics.

Before I go into my comments I ought to provide some background on what is meant by the “Multi-Site Hedonic Analysis”. Initially I thought the “Hedonic” had to do with some special techniques being used, but later found out that hedonic is merely an offshoot from the word “hedonism” and simply refers to analyzing intangibles – like scenic values or wind turbine nuisance. The techniques used are “simply” standard regression analyses as would be performed in any number of other fields of study.

So, what is regression analysis? From Wikipedia:

“In statistics, regression analysis includes any techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables.”

In this case the one or more independent variables are things like square footage, number of bathrooms and distance from a wind turbine, while the dependent variable is the sales price of the house.

The general process is to decide which physical areas you want to study and the questions you want to answer. Hoen ended up choosing 10 areas as shown in Figure 1 on Abode’s page 30, his page 12. You then gather all the relevant information about the properties and he provides a good summary of how he did this in section 3. Once you’ve obtained the data – and you always end up obtaining more than you actually use – you start running the analyses, looking to show statistically that there is a relationship between, for example, distance and price. Note that statistical practitioners do not pose their quest as trying to show there is *not* a relationship between i.e. distance and price. You may recall the *null hypothesis* from your student days, where “no relationship” is the starting assumption.

One potential problem might have occurred to the alert (still awake?) reader is that house prices vary a great deal depending on a large number of often times intangible factors. This type of analysis takes a snapshot of all the sales in the study area, regardless of how big or little, nice or nasty, good shape or not. How likely is it we can

accurately ferret out the factor (i.e. distance from a turbine) we are interested in? The solution is to have a large number of data points. In Hoen's case, he had 7,459 sales, making this the largest and presumably most accurate analysis to date.

Hoen worked with about 15 major independent variables, some of which were continuously variable (like square footage) while others were sorted into categories. Using these 15 independent variables in varying combinations, he then created 10 different reports that studied different relationships between them and the dependent variable – the house selling price. The reports are listed in table ES-1, Adobe's page 12 and the study's page xi. Given my interest in close-in neighbors, I will focus my comments on these most relevant 4 out of the 10 reports: Base, All Sales, Temporal, and Repeat Sales. His overall conclusions are in table ES-2, immediately following ES-1, and generally he is not able to find any statistically significant (at the 90% level) relationship between the distance from or view of the wind turbines.

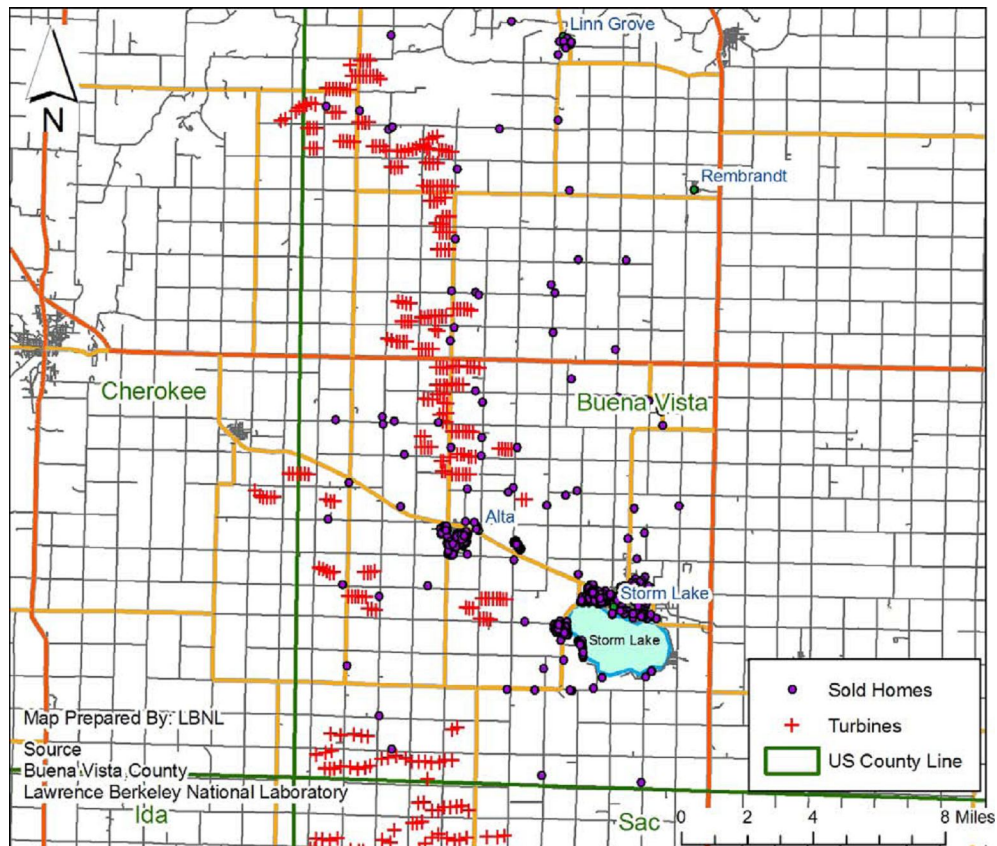
## Discussion

As mentioned earlier, my interest is in the close-in neighbors who can hear the turbines, labeled the "Nuisance Stigma". Fortunately, Hoen has this summary of these properties, from Adobe page 17, his page xv:

"Taken together, these models present a consistent set of results: homes in this sample that are within a mile of the nearest wind facility, where various nuisance effects have been posited, have not been broadly and measurably affected by the presence of those wind facilities. These results imply that Nuisance Stigma effects are either not present in this sample, or are too small and/or infrequent to be statistically distinguished."

Note carefully the last sentence. He has two potential explanations for this observed lack of effect. The first one, the effects are in reality not present, is what the wind industry dwells upon, and what Mr. Hoen himself mentions most prominently. But the second explanation, too small and/or infrequent to be called statistically significant, is equally possible. Of the 7,459 sales only 80 were within 3000 feet and another 65 inside one mile, for a total of 145, or 2%. Their prices did go down relative to everything else by varying amounts depending on the study, but that wasn't enough to trigger statistical significance most of the time. However, statistical significance has two basic requirements: that (1) the numbers are different and (2) they don't vary too much among themselves (the standard deviations are relatively small). Hoen won't release his raw data so others can sift through it, but among 140 properties from across the country I'd bet the differences would be very large. As an example, for the 7,459 sales the average price was 102,968 with the standard deviation of 64,293.

To give you a sense of how the properties are spaced relative to a project, here is a picture of the sales in the area with the most post-construction sales within one mile (Buena Vista County, Iowa, with 30 out of 125).



This chart is typical of the other 9; if anything, it is less extreme. Note the large number of sales in the towns of Alta and Storm Lake, both of which are pretty far from any turbines. To somehow use all these remote sales to draw conclusions about the relatively few close-in sales strikes me as quite a stretch. The obvious question to ask would be what sort of prices existed before the projects versus the prices after the projects for just the close-in properties, and one study in particular – the Repeat Sales Model – promises to provide that answer. Unfortunately, that model produced conflicting results as discussed below. Just as a snarky aside, there are actually 5 projects in this area; 3 of them were by Enron.

One oddly categorized variable was 5 different distances from a turbine – why wouldn't this be continuous? Hoen goes into overtime providing the reason in footnote 52 on his page 25. I can see his point about "imposing structure" but it does give him an excellent opportunity to game the data.

I don't know if Hoen used the distance categories to game the data or not. Without the raw data it is impossible to tell. But there's other ways to warp the data to get a result you can profit from. Buried in the footnotes on page 14:

"Finally, it should be noted that the authors are aware of four instances in the study areas when homes were sold to wind developers. In two cases the developer did not resell the home; in the other two, the developer resold the

home at a lower price than which it was purchased. But, because the sales were to a related party, these transactions were not considered “valid” and are therefore not included here. One might, however, reasonably expect that the property values of these homes were impacted by the presence of the wind turbines.”

Those 2 resold properties were at the Somerset, PA project – the one you can see from the PA Turnpike. From stopillwind.org:

“...Somerset Wind...bought these properties for fair market value—one in May, 2002 for \$101,049, reselling it in August to a lessor who had initially leased land to the wind company for \$20,000--20% percent of the previous sale price! In May, 2002, Somerset Wind purchased the other property for \$104,447, selling it in August for \$65,000--62 percent of the purchase price!”

I’ll concede the sales from the original owner to the developer are invalid. But the following sales are not “to a related party”. The developers are presumably rational and would want to sell these 4 properties for as much as they could, and in two cases that may well have been zero. The lower prices could well reflect what the properties are now worth. Given that the close-in property sample is so small, these 4 transactions make quite a difference – by my calculations (using average values), raising the Base model’s inside-a-mile decrease in property values from 5.4% to 9.2%. One wonders what the headlines would have said if those values were published. I have little doubt that difference would have been statistically significant. Hoen avoided the problem by simply discarding this inconvenient data.

Earlier I promised to discuss the 4 models that seemed to be the most germane for my close-in worries. Here they are, but Hoen has managed to eviscerate the models enough that no honest result is apparent.

#### **Base** (Section 4, his page 23)

This model is the centerpiece of the study, even getting its own section. It just considers the sales of properties after construction of the project begins. Hoen justifies this because of his emphasis on the visual aspects of wind turbines - after all you can’t measure them until the project is built. However, it also allows Hoen to avoid discussing the large price drop experienced by the close-in properties that occurs before the project is even constructed. Even then, he found that close-in properties decrease an average of 5.4%. As mentioned above, this is not statistically significant, perhaps because the sample is small and the variability is great.

Hoen comments,

“That notwithstanding, the -5% coefficients for homes that sold within one mile of the nearest wind turbine require further scrutiny. Even though the differences are not found to be statistically significant, they might point to effects that exist but are too small for the model to deem statistically significant due to the relatively small number of homes in the sample within 1 mile of the nearest turbine. Alternatively, these homes may simply have been devalued even before the wind facility was erected, and that devaluation may have carried over into the post construction period (the period investigated by the Base Model).”

How does Hoen explain this away? By referring us to the All Sales model, discussed below.

### **All Sales** (Section 5.3, his page 37)

While the Base model uses just properties that have sold after construction has started, the All Sales model includes all the sales both before and after the announcement and construction. Because the prices of the close-in properties declined even before the project was announced, the 5% decrease noted by the Base model now becomes larger, averaging 7%. This decrease becomes big enough to now be statistically significant. How does Hoen explain this away? By referring us to the Temporal Aspects model, discussed below.

### **Temporal Aspects** (section 5.4, page 42)

This model focused on the price changes over different periods both before and after the construction of a project. My interest, as always, is in the properties within one mile. As for other sections, the number of sales that are useful for my purposes is quite small, a total of 225 over the entire roughly 10-year period. How he got to 225 escapes me as I can identify only the previously-mentioned 145 properties within 1 mile, and this is too large a delta to be a rounding error. He divided the 225 sales into 6 periods and compared their prices with an average. The earlier periods show quite large drops that are statistically significant. But as the project is built and put into operation the drops lessen, never going away completely, but becoming insignificant. This allows Hoen to put “no” in the Nuisance Stigma column for Temporal Aspects in table ES-2. The most interesting result to me is that even 2 years before the formal announcement of a project the prices within a mile decrease by 13%.

### **Repeat Sales Model** (Section 6, his page 55)

This study took matched pairs of sales when there was one sale before announcement of a project and another sale after construction of the project. As such it does not use regression analysis. Unfortunately, the sample I’m interested



in, sales within one mile of the project, is quite small, a total of 14 properties. Curiously, it showed that these houses increased their value by 3% per year over the average. This is encouraging, but the sample size is small and there are other inconsistencies in the results in this section, so I'm not sure what to make of the results. Nor is Hoen:

“These results are counterintuitive and are likely driven by the small number of sales pairs that are located within one mile of the wind turbines and experience a dramatic view of those turbines.”

Maybe the solution to this odd result is contained in the Temporal Aspects Study. From that study, it seems that prices of houses within one mile drop a great deal beginning before the project is even announced, and then recover somewhat as time goes on. The repeat sales pairs could be reflecting this recovery from a depressed beginning.

### Other Critiques

I've bored you enough. I've even bored me enough. Here are some critiques from others, all of whom have more insight into real estate and statistics than I.

One of the reviewers was Lisa Linowes of the Industrial Wind Action Group – better known as windaction.org. She had this to say about her critique:

“We worked closely with an appraiser experienced in regression analysis and hedonics in developing our comments. Given the flaws in Hoen's approach, we are confident that a qualified appraiser with experience in regression techniques and the problems of hedonic analysis will effectively counter Hoen's conclusion. You may be interested to know that neither Hoen or the others who were part of his research team have any experience in real estate appraisals or the correct application of regression techniques for determining house value.”

Her critique is posted on their web site at <http://www.windaction.org/documents/24178> and a backup copy is at <http://windfarmrealities.org/wfr-docs/linowes-hoen-critique.pdf> .

For a shorter version and some additional commentary, visit windaction.org <http://www.windaction.org/releases/25672> also saved at <http://windfarmrealities.org/wfr-docs/iwa-hoen-critique.pdf> .

Albert R. Wilson is another professional real estate appraiser, and while he has (correctly) no opinion on wind turbines and property values, he eviscerates Hoen's techniques at <http://www.arwilson.com/pdf/newpdfs/WindFarmsResidentialPropertyValuesandRubberRulers.pdf> also saved at

<http://windfarmrealities.org/wfr-docs/wilson-hoen-critique.pdf> .

Michael McCann, a professional appraiser in Illinois and the Midwest was another reviewer along with Lisa, and he had two comments. The first one mentioned that this study would likely be used in official government proceedings, and an emphasis on the disclaimer would be a good thing. Link at

<http://www.windaction.org/?module=uploads&func=download&fileId=1948> with a backup copy at

<http://windfarmrealities.org/wfr-docs/mccann-hoen-review-disclaimer.pdf> .

He goes on to write a longer and in many ways a harsher critique than mine, at

<http://www.windaction.org/?module=uploads&func=download&fileId=1950>

with a backup copy at

<http://windfarmrealities.org/wfr-docs/mccann-hoen-review-total.pdf> .

The Acoustic Ecology Institute had the same sorts of concerns with the close-in neighbors, and noticed some of the same things I did, per

<http://aeinews.org/archives/529> .