

# Impact of the Lempster Wind Power Project on Local Residential Property Values

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## Executive Summary

With wind energy projects expanding throughout the United States—and New Hampshire—there is the need to provide local communities considering project development with good quality information on the potential environmental and economic impacts of wind project development. One area of concern is the impact that wind energy projects may have on residential property values. This is a valid concern given that studies have shown negative property value impacts near high voltage transmission lines and some forms of power generation facilities.

This study investigates residential property values around Iberdrola’s 24-megawatt (12 turbine) wind power project located in the Town of Lempster in Sullivan County, NH. This is the first significant wind energy installation in New Hampshire which became operational in the 4<sup>th</sup> quarter of 2008. The Lempster project serves as a good case study to indicate the impact of wind energy development on property values in New Hampshire.

Since the completion of project construction, there have been 16 arms-length single family home property transactions in Lempster and 72 arms-length single family home property transactions in the bordering towns of Goshen, Marlow, Unity and Washington. This analysis also considered 2,065 property transactions throughout Sullivan County from January 2005 through November 2011 to compare Lempster area property values to the overall region.

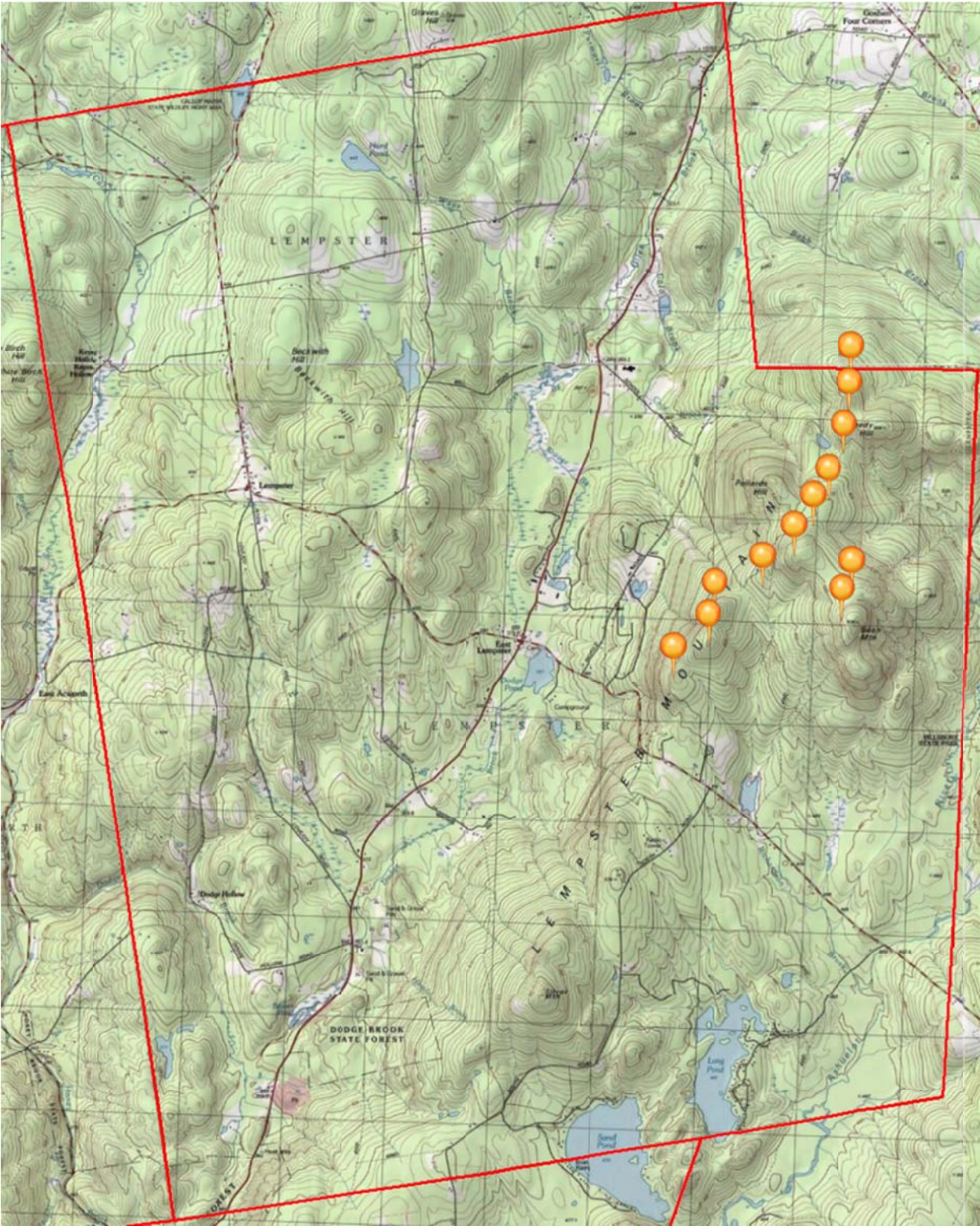
**Table 1: Summary of Findings at the Lempster Wind Power Project**

Scope			Statistically-significant Findings			
Location	Wind Farm Facilities	Property Transactions	Area Impact	View Impact	Nuisance Impact	Anticipation Impact
Local ( 1 State: NH)	1	2,593	None	None	None	n/a

All wind energy projects have their own unique characteristics including: the amount of residential and commercial development, terrain, and geographical features. An important feature of the Lempster Wind Power Project is that the area’s hilly terrain and high level of forest cover obscure or block views of the turbines and limit clear visibility of the turbines to a relatively limited number of locations. Only 10% of the sales transactions that have occurred in the local area have had an obscure or clear view of one or more turbines.

While this study does not exclude the possibility of isolated cases of property value impacts attributable to the Lempster Wind Power Project, this study has found no evidence that the Project has had a consistent, statistically-significant impact on property values within the Lempster region. This is consistent with the near unanimous findings of other studies—based their analysis on arms-length property sales transactions—that have found no conclusive evidence of wide spread, statistically-significant changes in property values resulting from wind power projects.

Figure 1: Town of Lempster with Wind Turbine Locations



Source: ESRI, USGS

## Introduction

The Town of Lempster is located in Sullivan County, New Hampshire. The town has a total area of 33 square miles and had a population of 1,150 in 2010. The region is rural, heavily forested, and features hilly terrain including Lempster Mountain and Bean Mountain whose summit is 2,326 feet above sea level. The town also has several bodies of water that account for 1.2% of the total area of the town and include: Dodge Pond, Long Pond and Sand Pond. There are two settlement areas in Lempster: the town center (Lempster village) and the village of East Lempster.

The major road routes in Lempster are: Route 10 (runs north to south through the center of Lempster), Second New Hampshire Turnpike (runs northwest to southeast up to the center of Lempster) and Mountain Road (runs northwest to southeast from the center of Lempster). Commercial establishments are primarily located along Route 10 and residential housing units are dispersed throughout Lempster. Lempster is bordered by the towns of Goshen and Unity to the North, the Town of Washington to the East and South, the Town of Marlow to the South and the Town of Acworth to the West.

The Lempster Wind Power Project is a 24-megawatt wind farm that began commercial operations in October 2008. The project is the first modern, commercial-scale wind farm in New Hampshire. The project is located in the eastern portion of Lempster on approximately 1,500 acres of privately owned land—with the project impacting only 5% of the land cover—and consists of 12 Gamesa G87 2 MW wind turbines stretching over several connected ridgelines on Lempster Mountain and Bean Mountain.

The northern-most wind turbine is just south of the Town of Goshen and nearby to the east is Pillsbury State Park in the Town of Washington. Pillsbury Park is heavily wooded and covers 8,135 acres which significantly limits the number of residential properties immediately east of the Project. Also noteworthy, two radio towers (not related to the Project) are located approximately one mile southwest of the Project with heights of about 350 feet.

The Gamesa G87 turbines stand 396 feet to the tip of blade and have a tower hub height of 256 feet and a blade length of 139 feet. Each of the turbines is located within 700 to 850 feet of another turbine and the turbines are accessible via 5 miles of gravel surfaced roads. The Project is interconnected to the Public Service of New Hampshire (PSNH) Newport substation by a 10.5-mile 34.5 kilovolt (kV) distribution line and features a 34.5 kV switchyard with pole mounted equipment and a 34.5 kV underground collector feeder system.<sup>1</sup>

Iberdrola Renewables, Inc. owns the Lempster Wind Power Project. Iberdrola Renewables is the second-largest wind operator in the U.S. and also operates more than 621 MW of gas-fired generation. Iberdrola Renewables is the U.S. division of parent company Iberdrola, S.A., Spain's largest energy group

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<sup>1</sup> "Lempster Wind Power Project Fact Sheet," Iberdrola Renewables, Available online at [http://www.iberdrolarenewables.us/cs\\_lempster.html](http://www.iberdrolarenewables.us/cs_lempster.html)

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and the fourth largest utility company in the world by market capitalization. Iberdrola, S.A. features the largest renewable asset base of any company in the world.<sup>2</sup>

PSNH has a power purchase agreement with Iberdrola for 100% of the electricity generated from the Project. PSNH resells a portion of the power from the Project to the New Hampshire Electric Cooperative, a local electric service provider that includes the town of Lempster in its service territory.<sup>3</sup>

**Figure 2: Lempster Turbines from Nichols Road (Approximately 0.6 Miles) – Dec. 2011**



### Study Sponsor

Antrim Wind Energy, LLC (AWE) contracted with Professor Ross Gittell and Matthew Magnusson from the University of New Hampshire's Whittemore School of Business and Economics to independently examine the impact of the Lempster Wind Power Project on local residential property values. This study is intended to inform the members of the New Hampshire Site Evaluation Committee around the question of the potential impacts on local property values from wind power facilities such as the proposed Antrim Wind Energy Project ("the Project"). This study utilizes both a literature review and primary research on property transactions around the Lempster Wind Power Project in Lempster, New Hampshire to support its findings. In conducting this economic analysis, emphasis was placed on providing conservative analysis of the residential property impacts of the Lempster Wind Power Project.

Antrim Wind Energy, LLC ("AWE") is a Delaware limited liability company formed in 2009 as a special purpose entity to develop, build, own and operate the Antrim Wind Energy Project. AWE has two members – Eolian Antrim, LLC and Westerly Antrim, LLC who each own and control 50% of AWE. Both of these members are registered Delaware limited liability companies and are owned by Eolian

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<sup>2</sup>"Business Overview," Iberdrola Renewables, Available online at <http://www.iberdrolarenewables.us/business-overview.html>

<sup>3</sup>"Twelve New Wind Turbines Nearing Completion at New Hampshire's First Wind Project," Iberdrola Renewables, October 7, 2008, Available online at [http://www.iberdrolarenewables.us/rel\\_08.10.07.html](http://www.iberdrolarenewables.us/rel_08.10.07.html)

Renewable Energy, LLC (“Eolian”) and Westerly Wind, LLC (“Westerly”), respectively. Westerly is a portfolio company of US Renewables Group (“USRG”). AWE operates from the offices of Eolian Renewable Energy, LLC at 155 Fleet Street, Portsmouth, NH 03801

## Potential Residential Property Value Impacts of Wind

Areas of concern for host communities of wind power projects often include visual impacts and turbine noise.<sup>4</sup> Related to these concerns are that potential adverse impacts from a wind energy project will negatively impact property values.<sup>5</sup>

Residential properties can be thought of as a bundle of characteristics that have value (square footage, number of bedrooms and bathrooms, plot size, condition, etc.). Location and the characteristics of that location also have value. The view from a property is a location-based characteristic that has been shown to have positive value when it is perceived to be pleasant or desirable (such as waterfront property or mountain vista) and negative value when it is perceived to be unpleasant or undesirable (such as a waste landfill). Related to the electrical power sector, reductions in residential property values have been found for properties in relation to power transmission lines and conventional power generation facilities.<sup>6</sup>

The possible negative impacts of wind energy projects on residential property values can be divided into the following four categories listed in Table 2.

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<sup>4</sup> Devine-Wright, P., “Beyond NIMBYism: towards an Integrated Framework for Understanding Public Perceptions of Wind Energy”, *Wind Energy*, 2005, 8:125-139.

<sup>5</sup> Firestone, J. and Kempton, W., “Public Opinion about Large Offshore Wind Power: Underlying Factors”, *Energy Policy*, 2006, 35(3): 1584-1598. Available online at <http://www.ceoe.udel.edu/windpower/docs/FireKemp07-PubOpinUnderly.pdf>

<sup>6</sup> Simons, R. A. and Saginor, J. D., “A Meta-Analysis of the Effect of Environmental Contamination and Positive Amenities on Residential Real Estate Values,” *Journal of Real Estate Research*. 2006, 28(1): 71-104. Available online at [http://business.fullerton.edu/finance/journal/papers/pdf/past/vol28n01/05.71\\_104.pdf](http://business.fullerton.edu/finance/journal/papers/pdf/past/vol28n01/05.71_104.pdf)

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**Table 2: Wind Power Project Negative Impact Categories**

<b>Negative Impact</b>	<b>Description</b>
<i>Area</i>	A general negative image of the wind energy project may adversely affect property values in the local community regardless of whether any specific property has a view of the wind turbines or not.
<i>View</i>	Property values with views of the turbines may be devalued because of the potential visual impact of the view that existed prior to turbine installation.
<i>Nuisance</i>	Property values in close proximity of the turbines may be devalued due to factors, such as turbine noise, and shadow flicker. Shadow flicker occurs when a specific set of conditions (location, wind direction, sun height) combine to cause the turbine blades to cast shadows. <sup>7</sup>
<i>Anticipation</i>	Property values in the local community may decline before, during, and immediately after construction of the wind project due to existing property owners' fear that the project will negatively impact the area. This impact would occur before the actual operating characteristics of the wind project are known.

The “bundled” value of all of the characteristics of a property is expected to be revealed when a buyer and a seller engage in a market-based transaction for that property. Therefore, the different potential impacts can be tested for objectively by looking at arms-length property transactions, as was the case in this study.

An area impact can be determined by comparing the sales of similar homes within the general area of a project with sales of similar homes in different nearby communities. If a wind project had an area impact then all homes in that community would be expected to have lower sales value relative to comparable homes in neighboring communities. Property transactions should also reveal if having a view of a wind project reduces the value of a property relative to other similar properties that do not have a view of a wind project in the region.

If close proximity (nuisance impact) to a wind project is a factor, than one should observe a reduced value for homes close to a wind turbine relative to other similar properties located further away from a wind turbine. Anticipation impacts would be expected to result in reduced sales prices that occur during the period of time in between when the community becomes aware of a wind project and construction completion of the project. Anticipation impact reflects the uncertainty property owners may have as to the actual impacts of a wind project. For example, prior to the completion of construction on a project, nearby property owners may wonder whether their view will actually change or whether potential impacts, such as shadow flicker or noise, from a nearby turbine will reduce a residential owner’s enjoyment of their property.

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<sup>7</sup> “Update of UK Shadow Flicker Evidence Base,” Prepared by Parsons Brinckerhoff for the UK Department of Energy and Climate Change, March 2011, Available online at <http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/ored/1416-update-uk-shadow-flicker-evidence-base.pdf>



## Review of Previous Studies

The impact of wind energy projects on residential properties has been explored in both the United States and in other countries. Different research techniques have been used including: homeowner surveys, expert surveys (such as surveys of real estate appraisers), and statistical analysis of property transactions. The body of research in this area has grown, increased in sophistication, and utilized larger data sets as more wind projects have been built.

Almost unanimously, statistical analysis of actual property transactions has not revealed a statistically-significant change in property values resulting after the construction of wind energy projects. Surveys of homeowners and experts have been more mixed as evidenced in some pre-project and post-project construction surveys. Some surveys have found statistically-significant expectations by survey respondents that property values will decline as a result of a wind power project.<sup>8</sup> While surveys can reveal homeowners' expectations of residential property value impacts from wind projects, the most reliable way to determine property value impact is not through surveys, but through analyzing actual market transactions. More in-depth discussions of previously performed studies can be found at Carter (2011), Hinman (2010), and Hoen et al. (2009).

In this study, a meta-analysis was conducted of six studies that collectively evaluated almost 50,000 property transactions in 11 different states. The studies reviewed are listed in Table 3. While the actual body of research in this area (the relationship between residential property values and wind energy projects) is much greater than six studies, these studies were chosen as they were believed to represent the best and most current research in the area of residential property values in relation to wind power projects.

The studies utilized actual arms-length property transactions in their analysis, tended to be more recent, utilized credible research methodologies, and typically had large transaction data sets. All but one of the reviewed studies found no statistically-significant difference in housing prices (as observed through actual market transactions) after wind energy projects were constructed. Heintzelman and Tuttle (2011) differed from the other five studies and reported a statistically-significant decline in property values (as witnessed through sales transactions) ranging from 8% to 18% due to the wind turbines in one geographic location in New York from the immediate time period preceding construction completion to immediately after project construction.

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<sup>8</sup> "Wind power sometimes hurts property values, Clarkson study says," Watertown Daily Times, July 20, 2011, Available online at <http://www.watertowndailytimes.com/article/20110720/NEWS03/707209999>

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**Table 3: Studies Reviewed of Residential Property Sales**

Study Author	Date	Scope			Statistically-significant Findings			
		Location	Wind Facilities	Property Transactions	Area Impact	View Impact	Nuisance Impact	Anticipation Impact
Hinman <sup>9</sup>	May 2010	Local ( 1 State: IL)	2	3,851	None	n/a	None	Negative
Hintzelman & Tuttle <sup>10</sup>	March 2011	Local (1 State: NY)	6	11,369	n/a	n/a	Negative	n/a
Hoen <sup>11</sup>	Apr 2006	Local (State: NY)	1	280	None	None	None	n/a
Hoen et al. <sup>12</sup>	Dec 2009	National ( 9 States: IA, IL, NY, PA, OK, OR, TX, WA, WI)	24	7,459	None	None	None	n/a
Carter <sup>13</sup>	Spring 2011	Local (State: IL)	3	1,298	None	n/a	n/a	n/a
Sterzinger et al. <sup>14</sup>	May 2003	National (7 States: CA, IA, NY,PA, TX, VT, WI)	11	24,346	None	n/a	n/a	n/a

<sup>9</sup> Hinman, J., "Wind Farm Proximity And Property Values: A Pooled Hedonic Regression Analysis Of Property Values In Central Illinois," Illinois State University, May 2010, Available online at <http://friendsofwind.ca/wp-content/uploads/2011/07/USA-2010-Hinman-Wind-Farm-Proximity-and-Property-Values.pdf>

<sup>10</sup> Hintzelman, M. and Tuttle, C., "Values in the Wind: A Hedonic Analysis of Wind Power Facilities," Clarkson University, March 2011, Available online at <http://docs.wind-watch.org/Values-in-the-Wind.pdf>

<sup>11</sup> Hoen, B., "Impacts of Windfarm Visibility on Property Values in Madison County, New York," Bard College, April 2006, Available online at [http://www.nhsec.nh.gov/2008-04/documents/app\\_appendix\\_30b.pdf](http://www.nhsec.nh.gov/2008-04/documents/app_appendix_30b.pdf)

<sup>12</sup> Hoen et al., "The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis," Ernest Orlando Lawrence Berkeley National Laboratory, December 2009, Available online at <http://eetd.lbl.gov/ea/ems/reports/lbnl-2829e.pdf>

<sup>13</sup> Carter, J., "The Effect of Wind Farms on Residential Property Values in Lee County, Illinois," Illinois State University, Spring 2011, Available online at <http://renewableenergy.illinoisstate.edu/wind/publications/2011%20Wind%20Farms%20Effect%20on%20Property%20Values%20in%20Lee%20County.pdf>

<sup>14</sup> Sterzinger, G., Beck, F. and Kostiuk, D., "The Effect of Wind Development on Local Property Values," Renewable Energy Policy Project, May, 2003, Available online at [http://www.repp.org/articles/static/1/binaries/wind\\_online\\_final.pdf](http://www.repp.org/articles/static/1/binaries/wind_online_final.pdf)

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Hoehn et al. (2009) is one of the most noteworthy studies and was prepared for the Office of Energy Efficiency and Renewable Energy in the U.S. Department of Energy. Their study analyzed almost 7,500 single family home sales within a 10 mile range of 24 existing wind projects in 9 U.S. states. Sales occurred between January 1996 and June 2007. The study used 8 different pricing models and the models consistently showed no evidence of widespread property value impacts in communities surrounding wind energy facilities. The models also found no evidence of change in property values related to distance to wind projects or views of wind projects. They concluded that while it was possible for individual or a small number of homes to have been negatively impacted by projects that the impact on property values was either too small or too infrequent to result in any statistically-significant, observable impact.

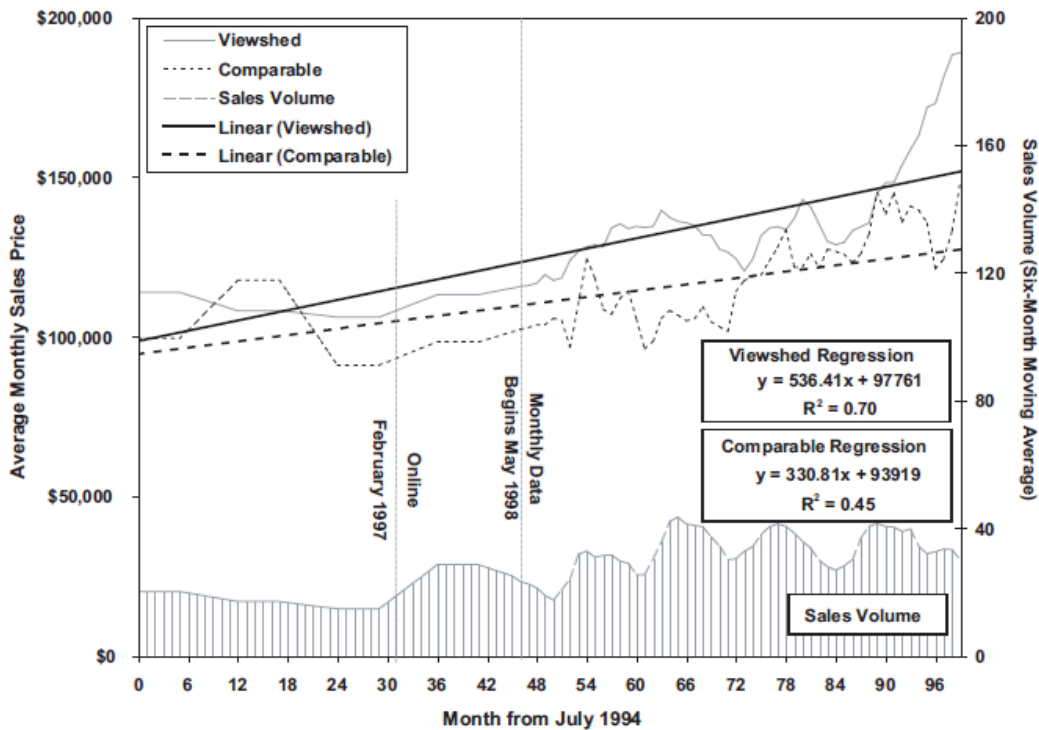
Sterzinger et al. (2003) analyzed the largest set of property transactions out of all of the studies considered and looked at properties transactions surrounding 11 wind projects in 7 different states over roughly a 6 year period for each area. The study used regression analysis to determine how property values changed over time in areas near wind projects and assessed them relative to a “comparable” community that was not located near a wind project. They found that there was no evidence to suggest that wind development harms property values.

Sterzinger et al. (2003) was also the only study out of the six studies evaluated to include an analysis of a New England wind facility. They considered the 6 MW Searsburg Wind Power Project in Searsburg, VT that was built in 1997. At the time, the Searsburg project was the largest wind power facility in the eastern part of the country. The facility consists of 11 turbines with a 131 foot hub height running along a mountain ridge line.

Sterzinger et al. (2003) analyzed 2,788 sales between 1994 and 2002 in the communities within a five-mile radius around the wind project which included the towns of Searsburg, Dover, Somerset, and Wilmington. Over the same time period, they analyzed 552 sales in the towns of Newfane and Whitingham, VT for comparison. They used three different regression models and found in all circumstances that the communities in the region around the Searsburg project had property value rates grow at a faster rate than the comparison communities, leading them to conclude that there was no evidence to suggest the Searsburg Wind Power Project has had a negative effect on residential property values in the local area. Also of note, Newfane Town Lister Doris Knechtel was reported to have stated that only 10% of homes in Searsburg, VT have a view of the Searsburg Wind Power Project. This is due to the hilly terrain and high level of forestation in the region.

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Figure 3: Comparison of Searsburg Wind Power Local Area Property Sales with Comparable Community



Source: Sterzinger et al., "The Effect of Wind Development on Local Property Values," 2003

Heintzelmen and Tuttle (2011) performed the only study that has had a finding of a statistically-significant decline in residential property values. Their analysis included 9,414 arms-length property transactions in Franklin and Clinton County, NY and considered 5 wind energy facilities consisting of 271 GE (1.5 MW) turbines that were constructed between 2008 and 2009. This analysis showed that for homes within 0.5 miles of a turbine the sales price decreased in the range of 11% to 18%. The average property in their sample sold for \$106,864, which implies a loss of between \$11,600 and \$19,000. For properties, within 1 mile of a turbine the decline in value was 8% to 15%, implying a loss of \$8,200 to \$16,000.

Although, Heintzelman and Tuttle (2011) did identify some isolated negative impact in two counties in NY, their results were also mixed. They also looked at property values around the Maple Ridge Wind Farm located in Lewis County, NY, a wind project completed in 2006 which consists of 195 Vestas V82 (1.65 MW) turbines. They analyzed 1,955 total property transactions and found no significant impact due to the wind turbines and in fact, some instances, of a positive increase.<sup>15</sup>

Hinman (2010) found evidence that housing values in areas of close proximity to wind turbines can temporarily decline during the period between when a project is announced up until when the project is completed. Hinman analyzed 3,851 total property transactions from 2001 to 2009 in 25 townships in

<sup>15</sup> "Wind power sometimes hurts property values, Clarkson study says," Watertown Daily Times, July 20, 2011, Available online at <http://www.watertowndailytimes.com/article/20110720/NEWS03/707209999>

## Impact of the Lempster Wind Power Project on Local Residential Property Values

McLean and Ford Counties, Illinois around the Twin Groves Wind Farm— a 240 Vestas V82 (1.65 MW) MW project covering 22,000 acres that was constructed in 2007 and 2008. Hinman found up to an 18% decline in property values **between project announcement and project completion** for nearby properties. However, Hinman also found that during the operational stage of the wind farm project, as the actual visual and noise impacts of the wind turbines become known, property values rebounded higher in real terms than they were prior to wind farm approval.<sup>16</sup>

An explanation for the decline in property values that occurred around Twin Groves Wind Farm in Illinois could be anticipation, or that some homeowners expected (or were at least uncertain about) negative impacts from the wind farm and, as a result, property sales transacted at lower values than would otherwise be expected. Hinman's finding of wind farm anticipation may explain the difference between what has been shown in some past surveys where people expect a decrease in prices due to wind farm projects and the actual property transaction data for properties sold after the construction phase of the project. Hinman's study indicates that if there is a temporary decline in property values, it is also possible that they can rebound once the uncertainty surrounding how homeowners are affected by the development disappears.

Therefore it is possible that the decline in property values observed by Heintzelman and Tuttle in Franklin and Clinton County, NY is a temporary phenomenon related to homeowner anticipation of negative property value impacts similar to that observed at the Twin Groves Wind Farm in IL. The wind power projects in Clinton and Franklin County were completed in 2008 and 2009. Given that Heintzelman and Tuttle's analysis did not include sales in 2010 or 2011, it is plausible that the observed decrease in values was due to homeowners' uncertainty with potential impacts and would be expected to be temporary, with the market value of these nearby properties returning to the market values of the overall region as the actual impacts of those projects become known. Further supporting this line of reasoning is that the decrease in property values in Franklin and Clinton County, NY was similar to the 18% decline observed by Hinman at the Twin Groves Wind Farm. Before a definite conclusion is reached on the impact of property values in Franklin and Clinton County, NY and its applicability to all wind project installations, it would be important to include analysis of more post-project construction transactions for that region.

While it does appear that anticipation—uncertainty of impacts—can help to explain the property value declines observed in two of the studies reviewed, it is also important to note that not all studies have shown that property values decline at any phase of the wind power project life cycle. In fact, it seems that these occurrences may be more the exception than the general rule and could possibly be explained in how wind project developers, and local and state government manage the project approval process and communication with stakeholders. Actions taken by these entities to reduce uncertainty, such as providing visual and noise simulation, or providing the opportunity for local community members of proposed projects to view first-hand similar projects, combined with studies of impacts from other projects could help reduce uncertainty and prevent any “panic” selling that may occur due to that uncertainty.

## Methodology

The research team obtained property sales and parcel records for all of the fifteen towns and cities in Sullivan County, NH— including the Town of Lempster. Real Data Corporation, located in Manchester, NH provided data for transactions occurring from January 2005 through November 2011. The research team only looked at warranty deed sales transactions of single-family homes as these arms-length transactions were deemed to be the best overall indicator of residential property market prices.

A total of 2,593 arms-length single family home sales transactions were statistically analyzed to observe if the Lempster Project had any broad impacts on residential property values in the local area. This analysis grouped sales into two categories for each town or city: 1) Pre-SEC decision, 2) and Post-SEC decision. Pre-SEC decision was for the time period from Jan 2005 up to July 2007 (when the NH Site Evaluation Committee issued a “Decision Issuing Certificate of Site and Facility with Conditions” for Docket No. 2006-01).

The time frame chosen for the PRE-SEC decision was based on expert judgment and believed to best reflect market values immediately leading up to the SEC decision on Lempster. Post-SEC Decision was for the time period from July 2007 through November 2011. The Post-SEC time frame was selected as it provided the maximum time period to observe any impacts of the project and also results in a weighted-average as sales transactions in 2010 and 2011 were weaker in the Sullivan County region overall.

All fifteen towns and cities in Sullivan County were included in this portion of the analysis with the exception of Sunapee. Sunapee was excluded as its average property sales price was well above the regional average and not useful for comparison purposes. The percent difference between average property values was compared across each town to see how property values changed during the period of time before and after the SEC decision. Analysis of Means (ANOM) was a statistical test used to highlight the towns that had average property sales transactions that were statistically different from the overall region.

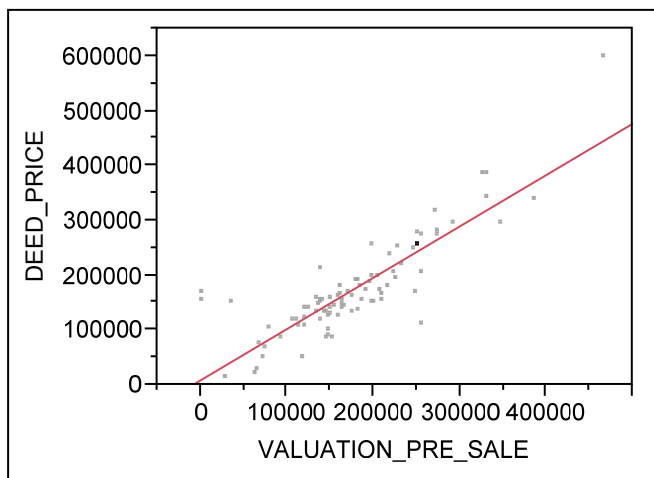
In addition, 88 property transactions occurred after the construction phase (the construction phase was defined in this study to have ended in September 2008) in the Town of Lempster and the bordering towns of Goshen, Marlow, Unity and Washington. Acworth was not included in this analysis as detailed parcel data was not available from Real Data Corporation for Acworth. These properties were mapped using Geographic Information Software (GIS) and with the assistance of Antrim Wind Energy, LLC, the research team developed a model showing the areas where the Lempster Wind turbines were likely to be visible. Mapped property locations were cross-referenced against the modeled turbine views to determine the properties that were expected to have a view of the turbines. All of these modeled locations were then “ground truthed” or visited by a member of the research team to ensure that they did have a view of the Lempster Wind Power Project. The views in those locations were categorized as either “none,” “obscure,” or “visible.” An obscure view was one where the turbines were somewhat visible but were blocked by some object, typically tree cover.

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View impact was tested using ANOVA statistical analysis to see if there was a statistically-significant difference between properties with no view, an obscured view, and a clear view of the turbines. Because of the small sample size, a hedonic analysis (one that uses characteristics of the property to develop an equation for sales price) was not used in this study. Previous studies have used either statistical analysis (as this study does) or a hedonic model.

Statistical analysis showed a strong correlation ( $0.73 R^2$ ) between the deed price (price of sale) and the presale valuation. This means that, as would be expected, the presale valuation was a good indicator of what the actual deed price was. As such, the view analysis was carried out in two steps: 1) Test to see if the groups that had an obscure view or clear view of one or more turbines had a statistically-significant different presale valuation than groups with no view, and 2) Test to see if the average difference between the deed price and presale valuation for all three categories of view showed a statistically-significant difference. If there was no statistical difference for both of these tests, than that would indicate that having a view of a turbine did not have a statistically-significant impact on property value. If either of these tests did show a significant difference than that conclusion could not be reached.

Figure 4: Deed Price by Presale Valuation



Nuisance was tested by looking at the correlation between a property's distance to the nearest turbine and the deed price. If distance was a significant factor, then some form of relationship would be expected to be observable.

## Analysis

This study did not find any indications of the Lempster Wind Power Project having any statistically-significant, wide area impacts on local area residential properties. Furthermore, this study did not find any evidence to support that having a view of one or more turbines or that proximity to a turbine had any consistent, statistically-significant impacts in relation to residential property values in Lempster or the surrounding local area communities. This is consistent with the findings from other studies, including those reviewed in this analysis.

This analysis did not specifically test for an anticipation impact (a decrease in property values between project announcement and completion), however that does change any of the conclusions from this study as this “anticipation” time period was included in the overall time period analyzed for impacts. It is expected had there been a significant anticipation impact, that it would have been uncovered when comparing the average sales prices in communities around the Lempster Wind Project with the overall region. Table 4 summarizes the findings in this study.

**Table 4: Study Findings**

Study Author	Date	Scope			Statistically-significant Findings			
		Location	Wind Farm Facilities	Property Transactions	Area Impact	View Impact	Nuisance Impact	Anticipation Impact
Magnusson & Gittell	Jan 2012	Local ( 1 State: NH)	1	2,593	None	None	None	n/a

## Area Impact

In Sullivan County (excluding Sunapee) the average value of a residential property (as witnessed through sales transactions) increased 3% from the 2.5 year period of time before the NH SEC decision on the Lempster Wind Power project to the 3.5 year period afterwards. Lempster and the three surrounding towns of Goshen, Unity and Washington, all showed increases in property value at or above the regional average for Sullivan County. For example, the Town of Lempster’s average sales price increased 3% from \$166,858 in the period of time before the SEC decision on Lempster to \$171,530 in the period of time afterwards. The Town of Acworth was only slightly below the regional average with an increase of 2% in residential property value.



## Impact of the Lempster Wind Power Project on Local Residential Property Values

**Table 5: Average Sales Price Before and After NH Site Evaluation Committee Decision**

Communities	PRE-SEC Decision (JAN 2005 – JUL 2007)	POST-SEC Decision (JUL 2007 – NOV 2011)	Percent Change
ACWORTH*	\$ 175,180	\$ 178,778	2%
CHARLESTOWN	\$ 158,368	\$ 163,810	3%
CLAREMONT	\$ 157,005	\$ 152,361	-3%
CORNISH	\$ 233,984	\$ 262,030	12%
CROYDON	\$ 192,731	\$ 220,942	15%
GOSHEN*	\$ 162,190	\$ 178,020	10%
GRANTHAM	\$ 300,068	\$ 304,406	1%
LANGDON	\$ 240,210	\$ 209,875	-13%
LEMPSTER	\$ 166,858	\$ 171,530	3%
NEWPORT	\$ 168,454	\$ 154,418	-8%
PLAINFIELD	\$ 214,216	\$ 251,169	17%
SPRINGFIELD	\$ 285,920	\$ 262,399	-8%
UNITY*	\$ 173,634	\$ 207,636	20%
WASHINGTON*	\$ 199,509	\$ 209,022	5%
<b>Sullivan County (except Sunapee)</b>	<b>\$ 201,214</b>	<b>\$ 206,481</b>	<b>3%</b>

\*Towns immediately bordering Lempster

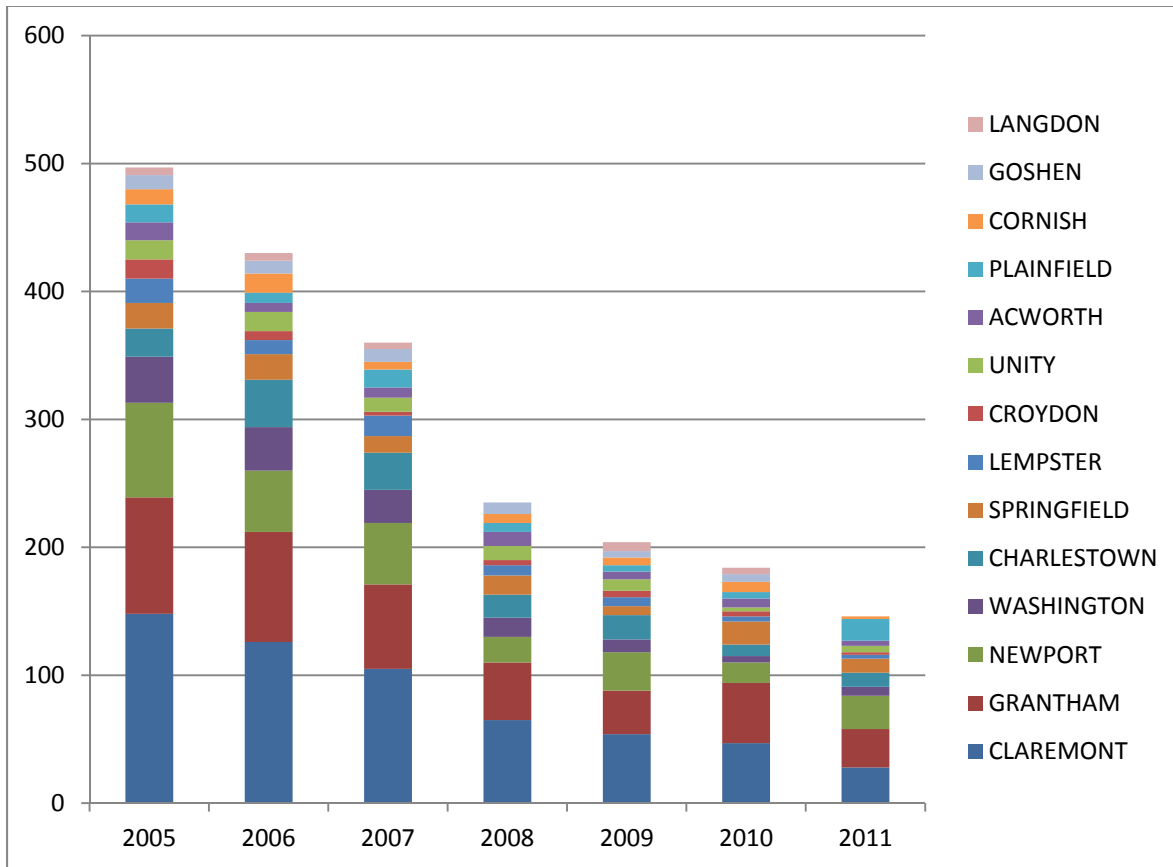
Overall, the region has shown a decline in sales volume, with 2011 sales transactions for Sullivan County (excluding Sunapee) being 30% of 2005 levels. The towns of Acworth, Goshen, Lempster, Unity, and Washington had 19 sales transactions in 2011 (through November 2011) which was 20% of the transaction level observed (95 transactions) in 2005. This steep decline is not unique to Sullivan County or New Hampshire as the overall U.S. housing market has been in a state of decline for the past several years.

**Table 6: Sullivan County (excluding Sunapee) Single Family Home Transactions from 2005 through 2011 (NOV)**

Town	2005	2006	2007	2008	2009	2010	2011
ACWORTH	14	7	8	11	6	7	4
CHARLESTOWN	22	37	29	18	19	9	11
CLAREMONT	148	126	105	65	54	47	28
CORNISH	12	15	6	7	6	8	2
CROYDON	15	7	3	4	5	4	2
GOSHEN	11	10	10	9	5	6	
GRANTHAM	91	86	66	45	34	47	30
LANGDON	6	6	5		7	5	
LEMPSTER	19	11	16	8	7	4	3
NEWPORT	74	48	48	20	30	16	26
PLAINFIELD	14	8	14	7	5	5	17
SPRINGFIELD	20	20	13	15	7	18	11
UNITY	15	15	11	11	9	3	5
WASHINGTON	36	34	26	15	10	5	7
Total	497	430	360	235	204	184	146

## Impact of the Lempster Wind Power Project on Local Residential Property Values

Figure 5: Sullivan County (excluding Sunapee) Single Family Home Transactions from 2005 through 2011 (NOV)



An Analysis of Means (ANOM) statistical test was applied to the average sales price for each town and city in Sullivan County for the period of time before and after the NH SEC decision on the Lempster Wind Power Project. This test highlights any cities or towns that show a statistically-significant difference from the regional average. Figure 7 shows the ANOM test for towns and cities in Sullivan County before the NH SEC decision. A green colored point marking the average sales price indicates that there is not a statistically-significant difference for that community and a red color point indicates that there is a statistically-significant difference in the average sales price for that community.

Before the SEC decision, the City of Claremont and the towns of Charlestown and Newport had average sales prices that were below the regional average and were statistically-significant. The towns of Grantham, Plainfield, and Springfield had average sales prices that were above the regional average and were statistically-significant. While the towns of Acworth, Goshen, Lempster, Unity, and Washington all had average sales prices that were below the regional average, none of these differences were statistically-significant from the regional average.

Impact of the Lempster Wind Power Project on Local Residential Property Values

Figure 6: Sales Transactions in Sullivan County in the Period of Time Preceding the NH SEC Decision (JAN 2005 – July 2007)

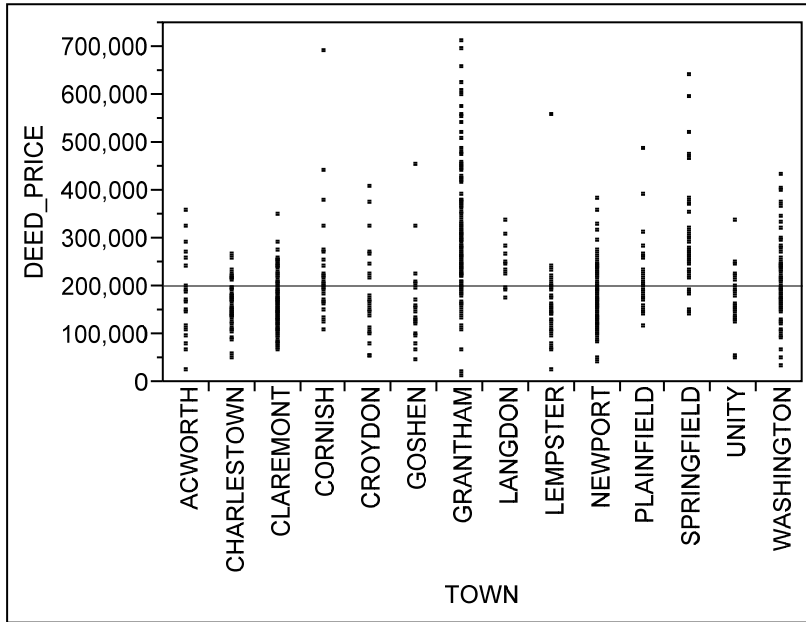
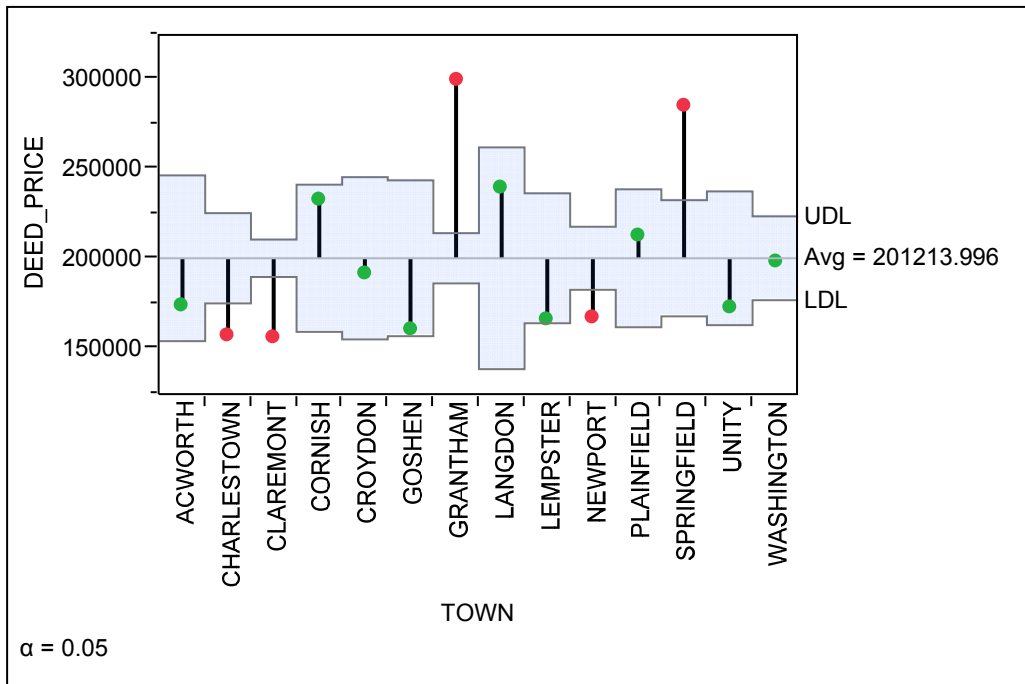


Figure 7: Analysis of Means in Sullivan County in the Period of Time Preceding the NH SEC Decision (JAN 2005 – July 2007)



Impact of the Lempster Wind Power Project on Local Residential Property Values

Figure 8: Sales Transactions by Town in the Period of Time After the NH SEC Decision (July 2007 – November 2011)

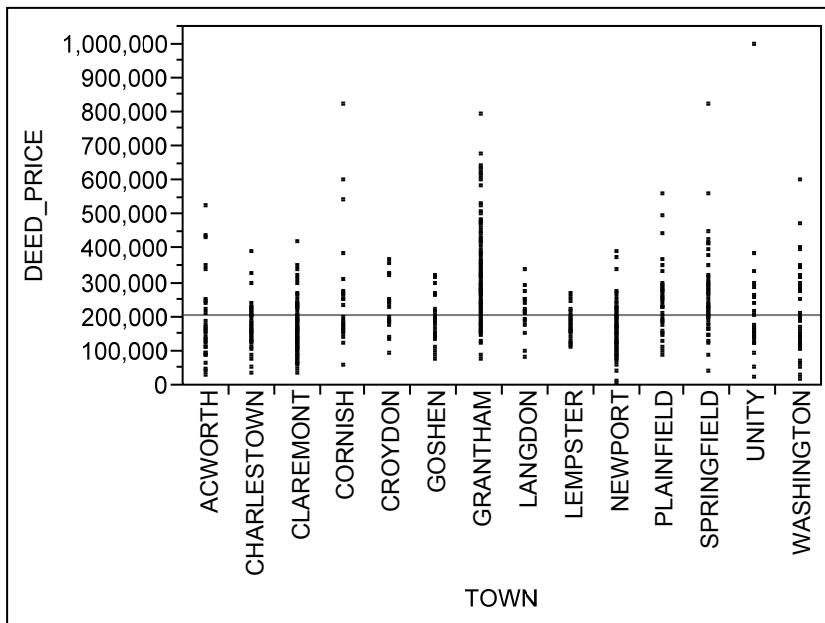
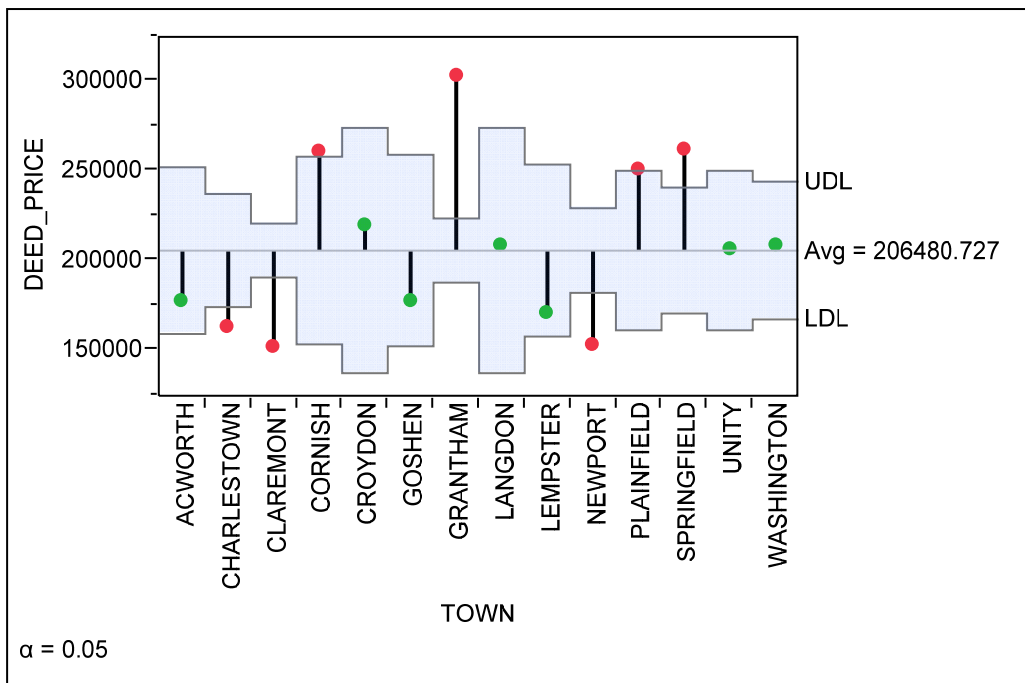


Figure 9: Analysis of Means by Town in the Period of Time After the NH SEC Decision (July 2007 – November 2011)



## Impact of the Lempster Wind Power Project on Local Residential Property Values

If the Lempster Wind Power Project had a consistent, observable, and statistically-significant impact on sales prices in Lempster and the surrounding communities, the ANOM test for the period of time after the NH SEC decision would be expected to show the average sales price for the Town of Lempster or other surrounding communities as statistically-significant and below the regional average sales price.

Figure 9 shows that while the towns of Acworth, Goshen, and Lempster all had average sales prices that were below the regional average after the NH SEC decision on Lempster, none of these differences were statistically-significant from the regional average. The Towns of Unity, and Washington had average sales prices that were slightly above the regional average, but the difference was not statistically-significant either. Therefore, there is no evidence to suggest that the Lempster Wind Power project had a consistent and statistically-significant impact on residential property values in Lempster or the nearby towns of Acworth, Goshen, and Washington.

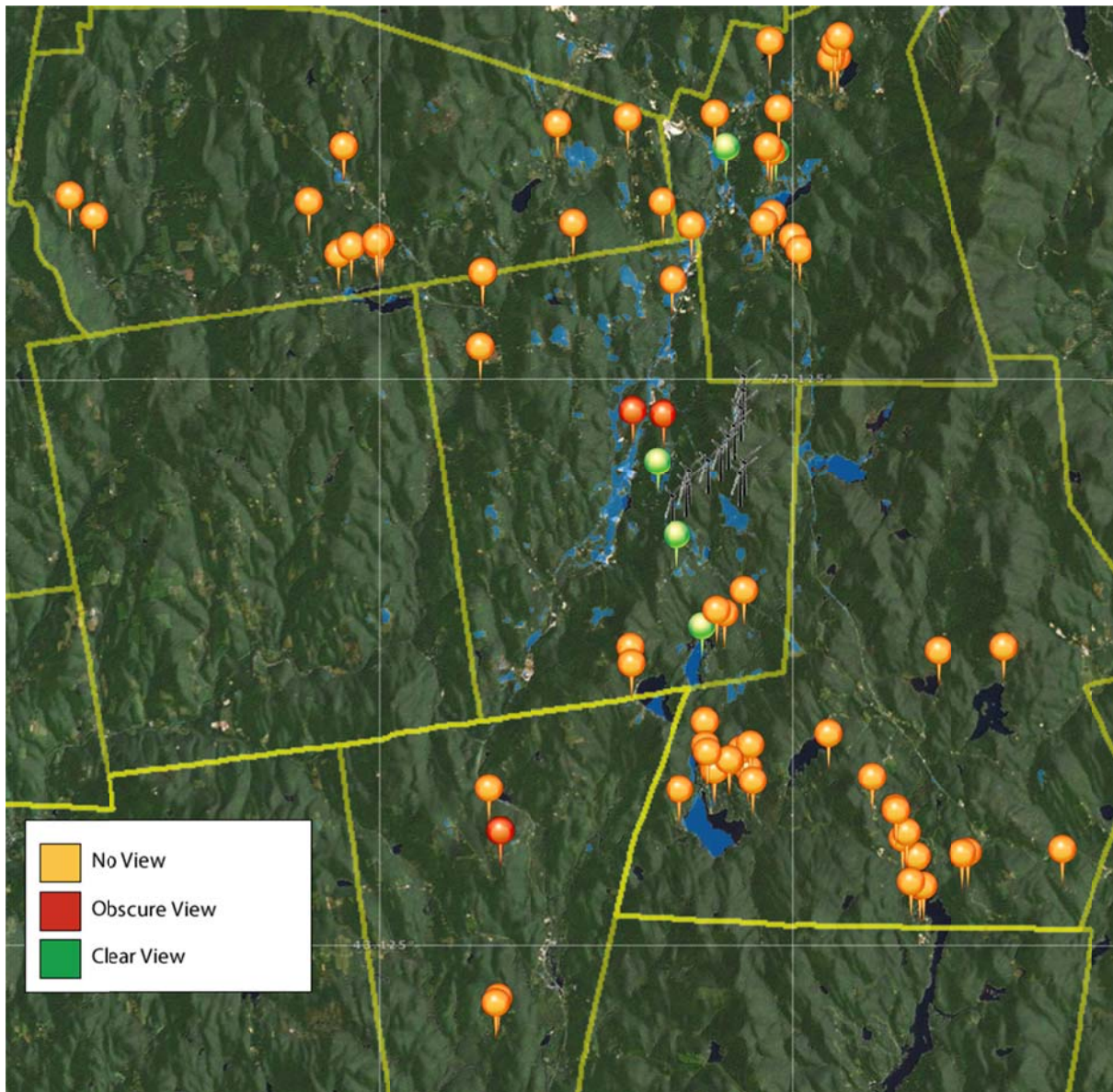
### Post Construction Sales Analysis

Overall, 88 arms-length single family home sales transactions were recorded in Lempster and the bordering towns of Acworth, Goshen, Marlow, Unity, and Washington after the construction of the Lempster Wind Power project (September 2008 through November 2011). Three (3.4%) were within a 1-mile radius of the nearest turbine, 16 (18%) were within a 3-mile radius of the nearest turbine, and 52 (59%) were within a 5-mile radius of the nearest turbine. Forty of the property purchasers (45%) reported the purchase was for primary residence and 46 (52%) reported the purchase was not for a primary residence.

**Table 7: Sales Transactions from Sep. 2008 to Nov. 2011 by Distance from Nearest Turbine**

Distance Miles	Count	Percentage	Cumulative
0-1	3	3.4%	3.4%
1-2	5	5.7%	9.1%
2-3	8	9.1%	18.2%
3-4	11	12.5%	30.7%
4-5	25	28.4%	59.1%
5-6	8	9.1%	68.2%
6-7	14	15.9%	84.1%
7-8	6	6.8%	90.9%
8-9	3	3.4%	94.3%
9-10	1	1.1%	95.5%
10-11	3	3.4%	98.9%
11-12	0	0.0%	98.9%
12-13	1	1.1%	100.0%
Total	88		

Figure 10: Post-Construction Property Transactions & Vegetative View shed in Lempster & Surrounding Communities



Source: Antrim Wind Energy, LLC (Vegetated View Shed)

Figure 10 displays the overlay of the vegetated view shed model (models in tree cover) of the Lempster Wind Power Project developed by Antrim Wind Energy, LLC with post-construction single family home sales obtained from Real Data Corporation. The modeled views were “ground-truthed” by the research team and found to accurately map the actual view shed of the turbines. As the figure illustrates, due to the area’s hilly topography and high level of forest cover, views of the turbines in the Project are restricted to a relatively specific range of locations. Modeled view locations are displayed as blue shaded areas in the map. Out of the post-construction property sales in the local region only 9 (10%) of the sales occurred for properties that had an obscure or clear view of one or more of the Lempster turbines.

## Impact of the Lempster Wind Power Project on Local Residential Property Values

Post-turbine construction, overall sales transaction volume and average sales price has decreased year over year in Lempster and the surrounding towns. This is not unique to this area as the overall NH and U.S. economy has been in a very weak housing marketing. In 2011, sales volume in NH increased only 1.8% and Sullivan County sales volume only increased 0.9%. The median sales price in NH decreased by 6.2% from 215,000 to 201,700. Sullivan County showed an overall decline of 10.3% with the median sales price decreasing from \$155,500 to \$139,500.<sup>17</sup>

**Figure 11: Sales Transactions from Sep. 2008 to Nov. 2011 by Wind Project View**

	2008 (Q4 only)		2009		2010		2011 (thru Nov.)		Total	
	Sales	Average Price	Sales	Average Price	Sales	Average Price	Sales	Average Price	Sales	Average Price
GOSHEN	5	\$126,146	5	\$153,200	6	\$198,333			16	\$161,625
None	4	\$120,950	4	\$154,000	6	\$198,333			14	\$163,143
Visible	1	\$146,933	1	\$150,000					2	\$148,6.5
LEMPSTER	2	\$167,500	7	\$174,857	4	\$171,300	3	\$122,333	16	\$163,625
None	1	\$180,000	3	\$158,333	4	\$171,300	3	\$122,333	11	\$155,545
Obscure	1	\$155,000	1	\$164,533					2	\$159,766
Visible			3	\$194,667					3	\$194,667
MARLOW	2	\$223,500	4	\$130,000	1	\$255,000	2	\$134,000	9	\$165,556
None	1	\$275,000	4	\$130,000			2	\$134,000	7	\$151,143
Obscure	1	\$172,000			1	\$255,000			2	\$213,500
UNITY	1	\$139,933	9	\$227,778	3	\$165,333	5	\$151,387	18	\$191,667
None	1	\$139,933	9	\$227,778	3	\$165,333	5	\$151,387	18	\$191,667
WASHINGTON	7	\$251,000	10	\$161,6.5	5	\$142,3.2	7	\$163,857	29	\$180,207
None	7	\$251,000	10	\$161,6.5	5	\$142,3.2	7	\$163,857	29	\$180,207
Total	17	\$194,118	35	\$176,714	19	\$175,789	17	\$149,941	88	\$174,580

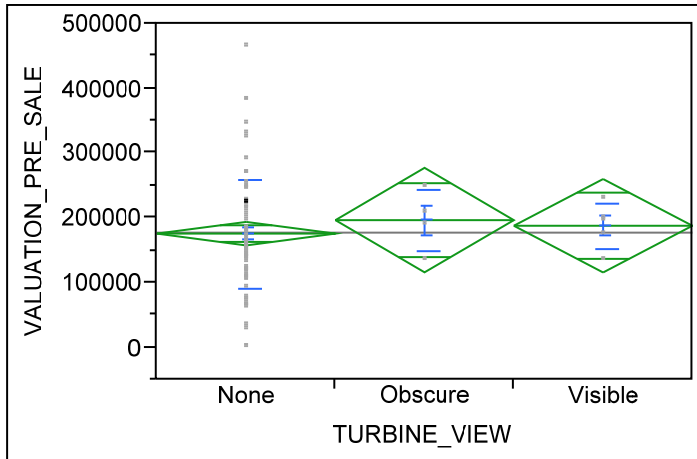
### Visual Impact

Statistical testing did not show a statistically-significant difference between the average presale valuation price of properties with no view, an obscure view, or a clear view of one or more turbines. Furthermore, there was not a statistically-significant difference between the sales price and the presale valuation for any of these groups. While caution must be used due to the small sample size, there is no evidence to support that an obscure or clear view of a wind turbine reduced the selling price of a property below what it should have been. This finding is consistent with other studies reviewed.

<sup>17</sup> "December 2011 Residential Sales: New Hampshire," New Hampshire Association of Realtors., Available online at <http://www.nhar.org/filemanager/download/32461/>

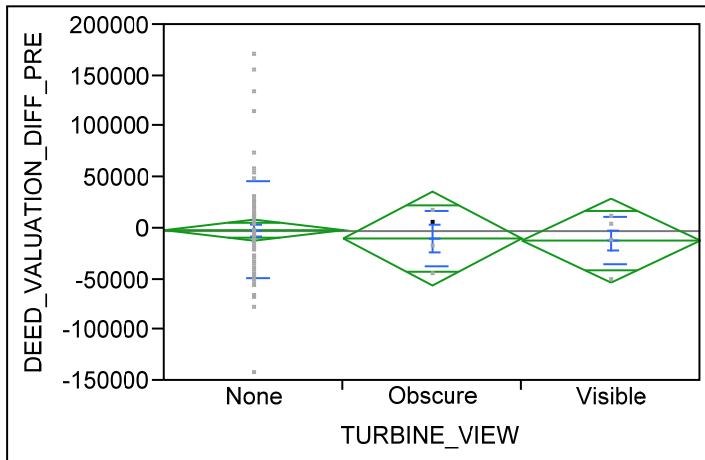
# Impact of the Lempster Wind Power Project on Local Residential Property Values

Figure 12: Analysis of Variance for Pre-sale Valuations of Post-Construction Property Sales



Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
TURBINE_VIEW	2	2263024199	1.1315e+9	0.1714	0.8428

Figure 13: Analysis of Variance Between Sales Transaction Price and Pre-Sale Valuation



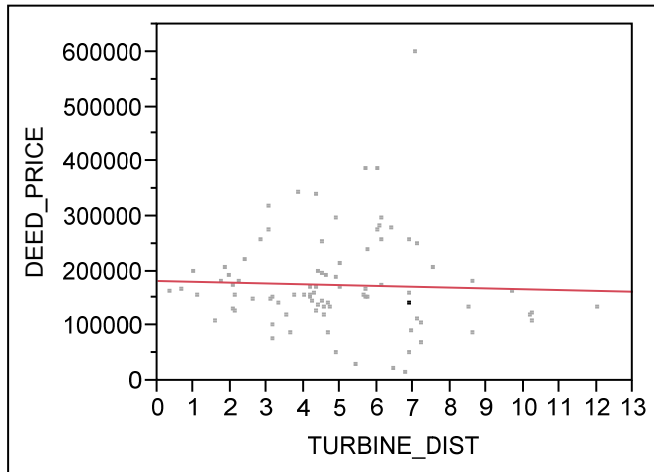
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
TURBINE_VIEW	2	712133056	356066528	0.1647	0.8484



## Nuisance Impact

Nuisance impact would be observable by looking at a correlation between distance from the nearest turbine and sales price. There was no correlation between turbine distance and sales price (0.002  $R^2$ ). For comparison purposes, acreage and square footage were also tested for correlation. Interestingly, acreage has basically no correlation with sales price (0.02  $R^2$ ), presumably as Lempster is a rural area and acreage is generally not scarce. However, square footage (as would be expected) does have a correlation (0.27  $R^2$ ), meaning that larger homes tend to sell for more than smaller homes, all other factors being equal. This finding of no nuisance factor is consistent with most other studies; however the sample size for properties very close to a turbine is very small, so caution must be used, especially at short distances.

Figure 14: Correlation of Sales Price to Turbine Distance

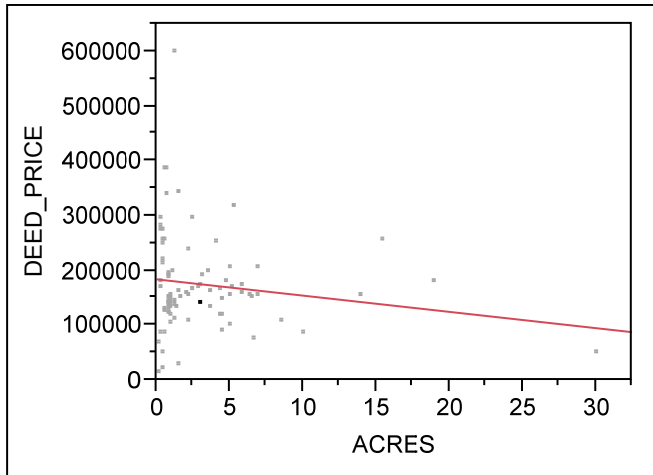


### Summary of Fit

RSquare	0.001568
RSquare Adj	-0.01004
Root Mean Square Error	88601.82
Mean of Response	174580.3
Observations (or Sum Wgts)	88

# Impact of the Lempster Wind Power Project on Local Residential Property Values

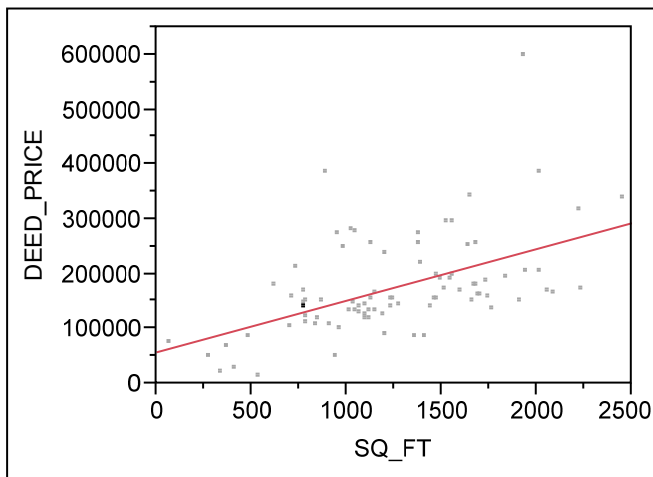
Figure 15: Correlation of Sales Price to Acreage



### Summary of Fit

RSquare	0.022509
RSquare Adj	0.011143
Root Mean Square Error	87667.71
Mean of Response	174580.3
Observations (or Sum Wgts)	88

Figure 16: Correlation of Sales Price to Square Footage



### Summary of Fit

RSquare	0.269353
RSquare Adj	0.260857
Root Mean Square Error	75794.42
Mean of Response	174580.3
Observations (or Sum Wgts)	88

## Additional Discussion

Another indicator of impacts would be residential complaints or similar actions. Research identified four distinct “complaints”. Iberdrola established a noise hotline after the Project was constructed, whose phone number is posted in the Lempster Town Hall. As of October 2009, Iberdrola had reported that two noise complaints had been received by the hotline.<sup>18</sup> In addition, the Town of Lempster has had two instances of tax abatement requests that were in part related to the wind project. The low number of complaints supports the overall finding of this study that while there is the possibility of isolated impacts that they are not expected to be consistent, wide spread, or statistically-significant.

**Table 8: Iberdrola Hotline Noise Complaints through October 2009**

Date	Complaint	Outcome
Aug-09	Resident located 1-mile from wind farm complained about noise from the wind farm.	Follow-up investigation found that there was a problem with the resident's hearing aid and that there was no noise audible from the Project.
Sep-09	Resident on Guildford Road (very close proximity to wind turbines) reported noise was noticeable at times.	A formal complaint was not filed.

Source: RSG, Inc.

**Table 9: Lempster History of Abatement Requests**

Assessment Date	Complaint	Outcome
May-09	Participating landowner stated "it's like living next to an airport" on abatement request, which also requested adjustment on other non-wind project related items. <sup>19</sup>	While the assessor noted, "it is not nearly the same (as living next to an airport)", the assessor did adjust several non-related items, but also recommended "Reduce view factor from 475 to 450...Add 10% economic depreciation for windmill close by" due to the Lempster Wind Project.
Jun-10	Resident on Guilford Road was concerned of over assessment due to proximity to one of the wind turbines.	Assessor adjusted several non-related items on property but did include an adjustment related to the wind project. Recommending "...the land lines be conditioned at 95 to reflect buyer resistance to the homes proximity to a wind mill."

Source: Town of Lempster Tax Records

<sup>18</sup> “Lempster Mountain Wind Farm: Post Construction Sound Survey,” RSG, Inc., October 2009, Available online at [http://www.nhsec.nh.gov/2006-01/documents/091104sound\\_report.pdf](http://www.nhsec.nh.gov/2006-01/documents/091104sound_report.pdf)

<sup>19</sup> Note, landowner has a wind turbine installed less than 500 feet from the residence, which is much closer than is typical and is over 5 times as close as any turbine is to any participating or non-participating landowner in the Antrim Wind Project.

## Conclusion

Given the significant investment that a residential property requires, it is not unreasonable to expect that homeowners would be concerned about the potential impacts of any significant infrastructure project nearby to that property, including wind power projects. This study analyzed property transactions from the end of construction of the Lempster Wind Power Project through November 2011. In that time period, 88 arms-length sales transactions for single family homes were conducted in the towns of Goshen, Lempster, Marlow, Unity, and Washington.

There were very few transactions within a very close distance to the turbines, and also very limited sales of properties with views of turbines, so some caution must be used in interpreting these results. Nevertheless, this analysis did not find any statistically-significant difference between the sales of homes within the view of one or more turbines and those with no view of a turbine. The analysis also did not find any evidence to indicate that distance to turbines (any indicator of nuisance) had any impact on sales price. Furthermore a review of over 2,500 property sales transactions in Sullivan County did not find any evidence to suggest that the property values in Lempster and neighboring communities were negatively impacted by the Lempster Wind Power Project relative to the overall region.

In some isolated cases (not observed in the case of the Lempster Wind Power Project), it appears that uncertainty about the impacts have resulted in a temporary decrease in value for properties located close to proposed wind power projects. It is expected that the process by which wind project developers and state and local government can help manage property owners' concerns will help reduce the potential for property values to sell for below their expected value during the phase between project announcement and completion.

All wind energy projects have their own unique characteristics and projects in New Hampshire tend to be located in hilly, highly forested regions. An important feature of the Lempster Wind Power Project, which is similar to the Antrim Wind Project, is that the area's hilly terrain and high level of forest cover obscure or block views of the turbines and limit clear visibility of the turbines to a relatively limited number of locations.

Another significant project in New England comparable to the Lempster Wind Power Project is the 11 turbine Searsburg Wind Power Project in Vermont. This project is located in topography similar to that of Lempster and has existed since 1997. Analysis of property transactions has not shown statistically-significant changes in property values in the Searsburg region as a result of that wind energy project.

Based on the analysis conducted in this study and taking into account other studies— based on arms-length sales property transactions—there is no evidence to suggest that the Lempster Wind Power Project has had any consistent, observable, statistically-significant impact on property values in Lempster or the communities surrounding the Project.