Wind Turbines and Residential Property Values:
An Overview of Research Findings and Where to Go From Here

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Impacts on Residential Property Values Near Wind Turbines

• Wind Energy and Property Values
  – Overview of Subject
  – Previous Literature
  – Berkeley Lab Research
  – Other Disamenity Research

• Where To Go From Here
Proximity to and Views of Environmental (Dis)Amenities Can Impact Property Values

<table>
<thead>
<tr>
<th>Highway</th>
<th>Transmission Lines</th>
<th>Average Home</th>
<th>Green Space</th>
<th>Ocean Front</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ $</td>
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</tbody>
</table>

- This linkage is well studied generally, but not for wind facilities
- The home/land is often the largest asset in resident’s portfolio
- Prior to wind facility construction, impacts (e.g., visual and auditory) to individual properties are difficult to quantify
Property Value Concerns for Wind Fall Into Three Potential Categories

1. **Area Stigma**: Concerns that rural areas will appear more developed

2. **Scenic Vista Stigma**: Concerns over decrease in quality of scenic vistas from homes

3. **Nuisance Stigma**: Potential health/well-being concerns of nearby residents

Each of these effects could impact property values; none are mutually exclusive
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Relatively Few Existing Wind and Property Studies

- **Variety of methods used**, from surveys to sales analyses, with varying levels of sophistication

- **Results are diverse**, and in many instances unpersuasive due to limitations in data and methodology

- **Variety of methods and sample type makes comparisons between results difficult**

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Author(s) Year</th>
<th>Number of Transactions or Respondents</th>
<th>Before or After Wind Facility Construction Commenced</th>
<th>Area Stigma</th>
<th>Scenic Vista Stigma</th>
<th>Nuisance Stigma</th>
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<tbody>
<tr>
<td><strong>Homeowner Survey</strong></td>
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<td>Haughton et al. 2004</td>
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<td>Bond</td>
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<td>- ?</td>
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<td><strong>Expert Survey</strong></td>
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<td>Grover 2002</td>
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<td><strong>Transaction Analysis - Simple Statistics</strong></td>
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<td>DeLacy 2005</td>
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<td>-/+ *</td>
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<td>Hoen, Wiser et al. 2009</td>
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<td>After</td>
<td>none</td>
<td>none</td>
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</tr>
</tbody>
</table>

"- *" indicates statistically significant negative effect at 10% significance level
"-/+ *" indicates positive and negative statistically significant effects at 10% significance level

"/'- ?" indicates statistically significant negative effect without statistical significance provided

"/-" indicates the majority of the respondents do not believe properties have been affected (for surveys) or that no effect was detected at 10% significance level (for transaction analysis)

"/-" indicates a negative effect without statistical significance provided

† Sales were collected after facility announcement but before construction
Conclusions Drawn From Previous Literature on Wind Energy and Property Values

- Wind facilities have been predicted to negatively impact property values by some (e.g., Haughton; Firestone et al.), sometimes by as much as 24-43% (Kielisch)

- Many experts (e.g., appraisers, assessors, realtors) have not experienced notable reductions in value (Grover; Goldman; Crowley) when surveyed after construction

- Large impacts (e.g., >10%) have failed to materialize when actual sales are investigated after construction (Poletti; Hoen; Sims & Dent; Sims et al.) except for one study of land sales (Kielisch)

- Impacts, to the degree that they exist, are most likely very near turbines (e.g., within ½ mile where they can be heard and seen) (McCann) and occur after announcement but prior to construction (Schnieder)
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• Where To Go From Here
Berkeley Lab Research Approach Responded to Limitations of Previous Work

- **Conducted literature review** of previous wind / property value studies and wind / public acceptance surveys, as well as potentially analogous studies on other disamenities (e.g. roads, power lines, power plants)

- **Collected large amount of data** on residential sales transactions occurring both pre- and post-construction surrounding a **representative sample** of wind facilities at **multiple locations** in the U.S.

- **Visited each home** to determine wind turbine visibility and to collect other important information about the home (e.g., the quality of the scenic vista)

- **Used multiple statistical models** to explore magnitude and statistical significance of potential effects, relying primarily on **hedonic model**

- **Tested for the presence of all three stigmas** – Area Stigma, Scenic Vista Stigma, and Nuisance Stigma

- **Rigorously analyzed** the data, culminating in an LBNL report and a journal paper
Berkeley Lab Project Involved Most Data-Rich and Comprehensive Analysis To Date

Research Questions
1) Is there evidence that views of turbines measurably affect sales prices?
2) Is there evidence that proximity to turbines measurably affect sales prices?
3) Do the results change over time, and are there other observable impacts?

Relevance
Provide stakeholders in siting/permitting processes greater confidence in the likely effects of proposed wind energy facilities, allowing greater consensus on often-contentious setback requirements, viewshed valuations and non-participating landowner arrangements.

Team
B. Hoen (Subcontractor to LBNL), R. Wiser (LBNL), P. Cappers (LBNL), M. Thayer (San Diego State University), G. Sethi (Bard College)

Funder
Collected Sales Data from 10 Study Areas Surrounding 24 Wind Facilities in 9 States

7,459 Residential Sales Transactions
1,754 Pre-Announcement, 4,937 Post-Construction, and 768 Post-Announcement-Pre-Construction

- Washington & Oregon: 3 Adjoining Counties
  7 Facilities: 582 WTG, 790 Sales

- Howard Cnty, TX
  46 WTG, 1,311 Sales

- Buena Vista Cnty, IA
  5 Facilities: 381 WTG, 822 Sales

- Custer Cnty, OK
  2 Facilities: 98 WTG, 1,113 Sales

- Kewaunee Cnty, WI
  2 Facilities: 31 WTG, 810 Sales

- Lee Cnty, IL
  103 WTG, 412 Sales

- Madison Cnty, NY
  Area 1: Madison
  7 WTG, 463 Sales

  Area 2: Fenner
  20 WTG, 693 Sales

- Wayne Cnty, PA
  43 WTG, 551 Sales

- Somerset Cnty, PA
  3 Facilities: 34 WTG, 494 Sales

Map Prepared By: LBNL

LBNL Study Areas
Wind Facilities > 0.6 MW Completed Before 2006
Represented States
Conclusions Based on This Sample

• **Area Stigma:** There is an *absence of evidence* that sales prices of homes without views of turbines and further than one mile from the nearest turbine are stigmatized by the arrival of the facility.

• **Scenic Vista Stigma:** There is an *absence of evidence* that sales prices of homes with a view of the turbines are uniquely stigmatized even if that view is “dramatic”.

• **Nuisance Stigma:** There is an *absence of evidence* that prices of sales occurring *after construction* of the facility for homes within a mile of the nearest wind turbine in this sample are affected and *some evidence* that sales occurring *prior to construction* are affected.

“Absence of Evidence” does not equate to “Evidence of Absence”

But if effects do exist in this sample, they are either too small and/or too infrequent to result in any statistically observable effect.
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- Where To Go From Here
Property Value Effects Found Near Other, Potentially More Risky, Disamenities Are In-Scale With Those For Wind Energy

<table>
<thead>
<tr>
<th>Disamenity</th>
<th>Study</th>
<th>Location</th>
<th>Percentage Change</th>
<th>Difference</th>
<th>Effect Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crematory</td>
<td>Agee and Crocker (2008)</td>
<td>Rawlings, WY</td>
<td>-2% to -16%*</td>
<td>within a mile</td>
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<tr>
<td>Superfund</td>
<td>Gayer et al. (2000)</td>
<td>Grand Rapids, MI</td>
<td>-4% to -6%*</td>
<td>within a mile</td>
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</tr>
<tr>
<td>Groundwater Contamination</td>
<td>Case et al. (2006)</td>
<td>Scottsdale &amp; Tempe, AZ</td>
<td>-7%</td>
<td>in currently contaminated area</td>
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<tr>
<td>Pre Remediation</td>
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<tr>
<td>Groundwater Contamination</td>
<td>Case et al. (2006)</td>
<td>Scottsdale &amp; Tempe, AZ</td>
<td>no difference</td>
<td>in previously contaminated area</td>
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<tr>
<td>Post Remediation</td>
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<tr>
<td>Waste Transfer Station</td>
<td>Eshet et al. (2007)</td>
<td>Israel</td>
<td>-12%</td>
<td>within a mile</td>
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<tr>
<td>Industrial - Superfund</td>
<td>Carroll et al. (1996)</td>
<td>Henderson, NV</td>
<td>-7%</td>
<td>within a mile 2.5 miles</td>
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<tr>
<td>Lead Smelter</td>
<td>Dale et al. (1999)</td>
<td>Dallas, TX</td>
<td>-0.8% to -4%</td>
<td>within a mile 2 miles</td>
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<tr>
<td>Power Plant</td>
<td>Davis (2008)</td>
<td>assorted</td>
<td>-3% to -5%</td>
<td>within 2 miles</td>
<td></td>
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<tr>
<td>Landfill - High Volume</td>
<td>Ready (2005)</td>
<td>assorted</td>
<td>-13%</td>
<td>adjacent to landfill 2 miles</td>
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<td>Landfill - Low Volume</td>
<td>Ready (2005)</td>
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<td>0% to -3%</td>
<td>adjacent to landfill 2 miles</td>
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<td>Landfill</td>
<td>Thayer et al. (1992)</td>
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<td>-2% to -5%</td>
<td>within a mile 4 miles</td>
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<td>Transmission Line</td>
<td>Hamilton &amp; Schwann (1995)</td>
<td>Vancouver, Canada</td>
<td>-6%</td>
<td>adjacent to tower 330 feet</td>
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<td>Transmission Line</td>
<td>Des Rosiers (2002)</td>
<td>Montreal, Canada</td>
<td>-10%</td>
<td>adjacent to tower 150 feet</td>
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<tr>
<td>Road Noise</td>
<td>Batemen et al. (2001)</td>
<td>Glasgow, Scotland</td>
<td>-0.4% to -4%</td>
<td>increase of 10 dBA**</td>
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<td>Road Noise - 29 Study Review</td>
<td>Batemen et al. (2001)</td>
<td>assorted</td>
<td>4% median of all studies</td>
<td>increase of 10 dBA**</td>
<td></td>
</tr>
</tbody>
</table>

* based on 2008 median house price (source: city-data.com)

** 10 dBA roughly represents the difference in noise between a busy road and a quiet street
Property Value Effects Are Relatively Low And Fade Quickly As Distance Increases Or Stigma Is Removed

- Homes within 1 mile of superfund sites, waste transfer stations, power plants, crematoriums, lead smelters have been found to decrease in value by no more than roughly 16% with most decreasing only roughly 8%

- Homes adjacent to landfills have been shown to decrease in value by 0% to 13%, depending on landfill volume, with all effects fading outside of 2 miles

- Homes located in areas with groundwater contamination have been shown to decrease in value by 7%, with no effects found after remediation

- Homes adjacent to high voltage transmission lines have been shown to decrease in value by roughly 8%, with all effects fading outside of roughly 350 feet, and most effects fading over time

- Homes adjacent to noisy roads have been shown to decrease in value by roughly 4%, as compared to homes on quiet roads, with 10 dB (A) lower sound levels
Conclusions From All Research Regarding Property Value Impacts From Wind Energy

- Risks of property value impacts after construction are often expected despite not having firm evidence that they exist.
- Similarly, in some scenarios, provisions to protect property values, and/or benefits to outweigh costs, are perceived as inadequate.
- Risks of property value impacts are highest when they cannot be accurately quantified, such as in the period after announcement yet prior to construction.
- Property value impacts after construction are most likely to exist near turbines (e.g., within earshot), and fade with distance and potentially time, but more research is needed to determine existence and extent of impacts.
- Cumulative impacts may exist for communities experiencing repeated wind development over many years.
- Given current research, economically significant impacts are not likely to exist outside of 1 mile even if turbines are visible.
- Effects are not likely to be larger than other more risky disamenities (e.g., superfund sites), yet more research is needed to determine where wind facility effects fit in the scale of effects from all disamenities.
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Property Value Risks Will Persist Unless They Are Measured, Mitigated and Managed

Measure

Continue to Measure to Better Understand Effects, to test the robustness of previous findings, and explore nuances in effects (e.g., changes over time)

- Use other techniques (e.g., paired sales, surveys, appraisals)
- Use similar techniques with other data (e.g., new facilities)
- Test for other analogous effects (e.g., time on the market, sales volume)
- Publish results in journals

Modulate as knowledge and methods evolve!
Property Value Risks Will Persist Unless They Are Measured, Mitigated and Managed

Mitigate

Increase efforts to quantify risks for those living closest so as to reduce risk adverse actions, and improve models and resulting regulations

- Organize visits to other facilities; having discussions with nearby residents (both participating and non-participating);
- Accurately depict for the local community likely visual and audio aspects; Use video to better describe aesthetic impacts
- Improve models to better predict visual (e.g., via LIDAR) and audio impacts (e.g., take into account wind sheer).
- Adjust regulations and maximum sound limits to take into account meteorological conditions and sound output under all operating conditions

Modulate as knowledge and methods evolve!
Property Value Risks Will Persist Unless They Are Measured, Mitigated and Managed

**Manage**

Manage risks in the short term for homeowners through tenable/workable measures

- Offer some combination of neighbor agreements/incentives and/or property value guarantees (e.g., Dekalb County, IL) to nearby homeowners as are economically tenable, legally workable, and practically available

- Conduct follow up studies (e.g., surveys, appraisals)

- Realize that cumulative impacts may exist

- Realize that real or perceived risks may increase/decrease as more/better information become available
Thank You!

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For a copy of the full LBNL report

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

http://eetd.lbl.gov/ea/ems/re-pubs.html

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