Wind farms 'can wipe one-third off house prices', MP claims

House prices can fall by as much as a third if wind farms are built in their vicinity, an MP has claimed

Geoffrey Cox MP said constituents had been told by estate agents their homes were worth "significantly less" due to turbines being built in the vicinity Photo: PA

By Emily Gosden, Energy Editor

5:43PM GMT 30 Dec 2013

Wind farms knock as much as one third off the value of nearby homes, an MP has claimed.

Geoffrey Cox, Conservative MP for West Devon and Torridge, said constituents had been told by estate agents their homes were worth "significantly less" due to turbines being built in the vicinity and that it was an "injustice" that they lose out while developers and land owners potentially pocket millions.

"An increasing number of people are coming to me with clear evidence that the value of their home is significantly less than what it otherwise would be were the wind farm not there.

"I'm seeing a minimum 10 per cent to 15 per cent reduction," he said.

"Some are seeing a loss of one-third of the value. How can that be fair?

"How can it be right that landowners and developers are making millions of pounds, while the ordinary household is losing the value of what is their pension, or nest egg in old age."

Renewable UK, which represents the wind industry, denied the claims, insisting that house prices are not affected by wind farms.

"The wind industry doesn't accept that there is any reliable independent academic evidence to suggest that wind farms have any effect on house prices," a spokesman said.

"The most recent study was done by the Royal Institute of Chartered Surveyors and that study was inconclusive. The Royal Institute now says there is no definitive answer to this question."

He added that communities living near wind farms were paid "large sums of money", which were this year increased from £1,000 a year for every megawatt (MW) of wind power capacity, to £5,000 a year.

A typical turbine might have a 2MW capacity, meaning a community near a 12-turbine wind farm could receive £120,000 a year.

Because these payments were used to improve infrastructure, this would "help to maintain the value of house prices in an area", he said.

Property experts have previously claimed that turbines, which campaigners say are a blight on the British landscape, can reduce the value of homes by up to eight per cent.

In August, the Telegraph revealed that a secret report into the impact of wind farms on rural house prices was being blocked by officials at the Department of Energy and Climate Change (DECC) amid fears it will conclude that turbines harm property prices.

Ed Davey, the Liberal Democrat energy secretary, had denied that anyone in his department is trying to suppress the report.

Meanwhile, Planning Minister Nick Boles has proposed direct compensation for lost property value due to infrastructure developments such as power projects.

He said he was considering a pilot scheme to look at "wherher people who have properties very close to a substantial development might benefit from some form of compensation for the loss of property value".

A similar scheme is used in the Netherlands, he said.

Mr Cox said the scheme should be implemented and used to compensate people living near wind farms.

"I would completely support households having to be paid compensation for the depreciation of their house value as a result of wind turbines," he said.

"It is simple nonsense for the pro-wind lobby to say they have no effect on house prices."

If you shut up truth and bury it under the ground, it will but grow, and gather to itself such explosive power that the day it bursts through it will blow up everything in its way.
EMILE ZOLA

Ten years too late, it's good riddance to wind farms – one of the most dangerous delusions of our age

Christopher Booker UK

"I have been following this (wind turbine) extraordinary story for ten years ever since, in 2002, I first began looking carefully at what really lay behind this deceptive obsession with the charms of wind power. It didn't take me long, talking to experts and reading up on the technical facts, to see that the fashionable enthusiasm for wind energy was based on a colossal illusion. I first warned about what I called 'the greatest mistake in our history' in an article in the Mail almost ten years ago.
I described the claim that it would be the answer to all our future energy problems as a catastrophic failure of judgment. I feared that windpower was stupendously inefficient and ludicrously expensive and that by falling for the greatest energy hoax of our time, the Labour government could be consigning Britain to a very dark future. So unreliable are wind turbines — thanks to the wind's constant vagaries — that they are one of the most inefficient means of producing electricity ever devised."

"The erection of a wind turbine creates apprehension in the general public, which makes the property less desirable and thus diminishes the prices of neighbouring property..." "Continuing scientific uncertainty over the adverse health consequences of wind turbines only serves to perpetuate the debilitating effect of

wind turbines on property prices."
Ben Lansink, Appraiser

Listen to [internet radio] with [Wind Wise Radio] on Blog Talk Radio

[Parish 'for sale' in protest at planned wind farms] »
« [Cash for 'silence' claim on turbines; Wind farm company offers cash settlements…]

Windfarms make homes unsellable

by Victoria Allen | Daily Mail | via [Scotland Against Spin]

Scots homeowners are seeing up to 50 per cent slashed from the value of their houses because of wind turbines, estate agents have warned.

Mounting evidence is emerging that the SNP's green crusade has wiped thousands of pounds from home values across the country. It comes as the Scottish Government launches a study into the link between house prices and turbines, which experts say will show homes near wind farms are almost impossible to sell. One local authority has already lowered council tax for one household, in recognition that its value has dropped because of turbines nearby. Families across the country also claim they have been trapped in their homes for years because noisy wind farms put off potential buyers.

Richard Girdwood, an estate agent previously working in Scotland and now at Winkworth in London, cut his valuation of one property by £40,000 because of surrounding turbines. He said: 'Wind turbines are beyond homeowners' control and they do have an impact of potentially tens of thousands of pounds.'

Estate agent Iain Robb, previously with Strutt & Parker in Glasgow, wrote to a homeowner about the impact of proposed turbines near his property. Mr Robb, who did not respond to requests for further comment, said house prices could be cut in half or more by wind farms. He wrote: 'In my personal view (as *distinct from a Strutt & Parker corporate view) the capital values of residential properties near to existing or intended wind farms suffer a minimum of 50 per cent diminution of their residential capital value. 'Properties next to sites where a planning application for a windfarm has been lodged are virtually unsellable.'*

Tas Gibson, 66, who received the letter, was forced to knock £300,000 off his home and four holiday lodges in Newton Stewart, Wigtownshire. A retired financial controller in the oil and gas industry, he bought his 18-acre Waterside estate as an investment and has been trying to sell it for 18 months. He said: 'The Scottish Government are just riding roughshod over ordinary people. Buyers are put off by the noise, the view and the effect on their health.'

Mr Gibson's neighbouring wind farm, 96-turbine Kilgallioch, is just 2.5 miles west of his property, has planning consent and is expected to be started next year. Another house, close to the 16- turbine Drumderg wind farm in Blairgowrie, Perthshire, was found by an assessor to have had 20 per cent wiped from its value and its council tax band was lowered as a result.

Joss Blamire, senior policy manager at Scottish Renewables, said: 'We have yet to see any conclusive evidence which links house and land prices with onshore wind farms. 'The sector continues to be an important driver of investment at a time of slow or negative economic growth, employing more than 11,000 people and attracting £1.6 billion of investment to the country's economy in 2012.'

A Scottish Government spokesman said: 'Current planning and consents processes are rigorous and ensure appropriate siting.'

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A Division of Wellington Realty Group Inc.

CASE STUDIES

Diminution / Change in Price

Melancthon and Clear Creek Wind Turbine Analyses Municipal Property Assessment Corporation (MPAC) Current Value Changes

Hwy 89, Melancthon Township, Ontario, Canada Photograph: Ben Lansink

Prepared by

Ben Lansink
AACI, P.App, MRICS

February 2013

Table of Contents

Diminution in Price, Melancthon & Clear Creek Conclusions

The two studies suggest price diminution as follows:

Conclusion: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines		
1	1480 Lakeshore Road, Norfolk	-44.17%
2	71 Norfolk County Road 23, Norfolk	-55.18%
3	47 Concession Road A, Norfolk	-22.47%
4	43 Old Mill Road, Norfolk	-32.96%
5	1575 Lakeshore Road, Norfolk	-27.67%
6	1527 Lakeshore Road, Norfolk	-28.88%
7	1921 Lakeshore Road, Norfolk	-38.48%
Median		**-32.96%**
Average		**-35.69%**
Low		**-22.47%**
High		**-55.18%**

Conclusion: Melancthon, 133 Wind Turbines		
1	375557 6th Line, Amaranth	-48.27%
2	97121 4th Line, Melancthon	-58.56%
3	504059 Highway 89, Melancthon	-23.24%
4	582340 County Road 17, Melancthon	-26.66%
5	582328 County Road 17, Melancthon	-37.30%
Median		**-37.30%**
Average		**-38.81%**
Low		**-23.24%**
High		**-58.56%**

None of the above properties considered in this report had a wind turbine erected on it. Registry facts and MLS® listings (if available) for these properties were obtained and are on file.

The Melancthon properties and neighbourhood were inspected and photographed by Ben Lansink on September 20, 2012.

The Clear Creek properties and neighbourhood were inspected and photographed by Ben Lansink on October 9, 2012.

Opinions about wind turbines – and their effect on property prices – are a relatively new phenomenon in Ontario (since 2005). Most people have an opinion regarding wind turbines and their effect on themselves, their surroundings, and society. The main concerns are the safety and health impacts of wind turbines.

If a wind turbine were erected on a property, would the neighbouring properties have the same market value as without the wind turbine? Does a wind turbine cause an increase or decrease in property value? There may be endless questions from a potential buyer and/or seller when dealing with a property affected by a wind turbine. When considering property value, these questions are difficult to quantify; however, the overall impact of a wind turbine can be analyzed within the actions of an open real estate market.

This study endeavours to isolate any loss in property price caused by a wind turbine. The construction and use of a wind turbine is an event over which a neighbouring property owner has no control. Each example in this study illustrates some type of 'harm' or 'injurious affection' that can be caused to a real property as a result of a wind turbine. The harm may be real or perceived and it may be different for each property and to each property seller and buyer.

This study analyzes specific examples that occurred within the open real estate market in order to isolate the impact on property value caused by a wind turbine.

Diminution, Obsolescence, Effects

Diminution in Value

Diminution in Value is a *loss in value* to a property caused by *obsolescence.* While the obsolescence may be curable, it may not be curable by a land owner.

For example, a land owner cannot move a hydro power transmission corridor or relocate a landfill operation nor can he move a Wind Turbine situated on land next to his land.

Obsolescence, one cause of diminution

- an impairment of desirability and usefulness caused by new inventions, changes in design, improved processes for production, or
- external factors that make a property less desirable and valuable for continued use
- may be either functional or external.

Source: The Appraisal of Real Estate, Second Canadian Edition

Harm

Most people have an opinion regarding obsolescence and the effect on themselves, their surroundings, their property, and on society. The harm may be real or perceived and it may be different for each property and to each property seller and buyer.

This perception is indicative of *how much one is willing to pay for a property***.**

TransAlta Corporation owns and operates the Melancthon Wind Facility through its wholly-owned subsidiary Canadian Hydro Developers, Inc. Based in Calgary, TransAlta is a public company listed on the Toronto Stock Exchange.

Canadian Hydro Developers, Inc. constructed Ontario's first utility-scale wind facility consisting of 133 industrial wind turbines producing 200 megawatts of power. Located near Shelburne, Ontario, Canada, the project is known as the 'Melancthon Wind Facility'. This facility has the capacity to generate 545,000 megawatt hours each year and twenty-year Renewable Energy Supply contract is in place with the Ontario Government. The Melancthon Technology is GE 1.5 MW turbines on 80 meter towers. Phase I of the project began commercial operation in 2006, with Phase II beginning commercial operation in late 2008.

In Ontario land use is controlled by the province through the *Planning Act, R.S.O. 1990, CHAPTER P.13.* Municipalities control land use through their Official Plans and Zoning by-laws. However, the Government of Ontario passed the *Green Energy Act, 2009* with the result that land use control regarding wind turbines was taken away from municipalities on May 14, 2009. On October 1, 2009, set-back regulations for wind turbines were implemented by *Ontario Regulation 359/09.*

The Melancthon Wind Facility project began in 2005 and was not subject to the Green Energy Act, 2009 or the set-back regulations implemented by Ontario Regulation 359/09.

Set-back Regulations for Wind Turbines in Ontario 550 Meters = 1,804.4 Feet

Item	Column 1	Column 2	Column 3
	Number of wind turbines calculated in accordance with subsection (2)	Sound power level of wind turbine (expressed in dBA)	Total distance from wind turbine to nearest noise receptor of the wind turbine (expressed in metres)
1.	1-5	102	550
		103 – 104	600
		105	850
		106 – 107	950
2.	6-10	102	650
		103 – 104	700
		105	1000
		106 – 107	1200
3.	11-25	102	750
		103 – 104	850
		105	1250
		106 – 107	1500

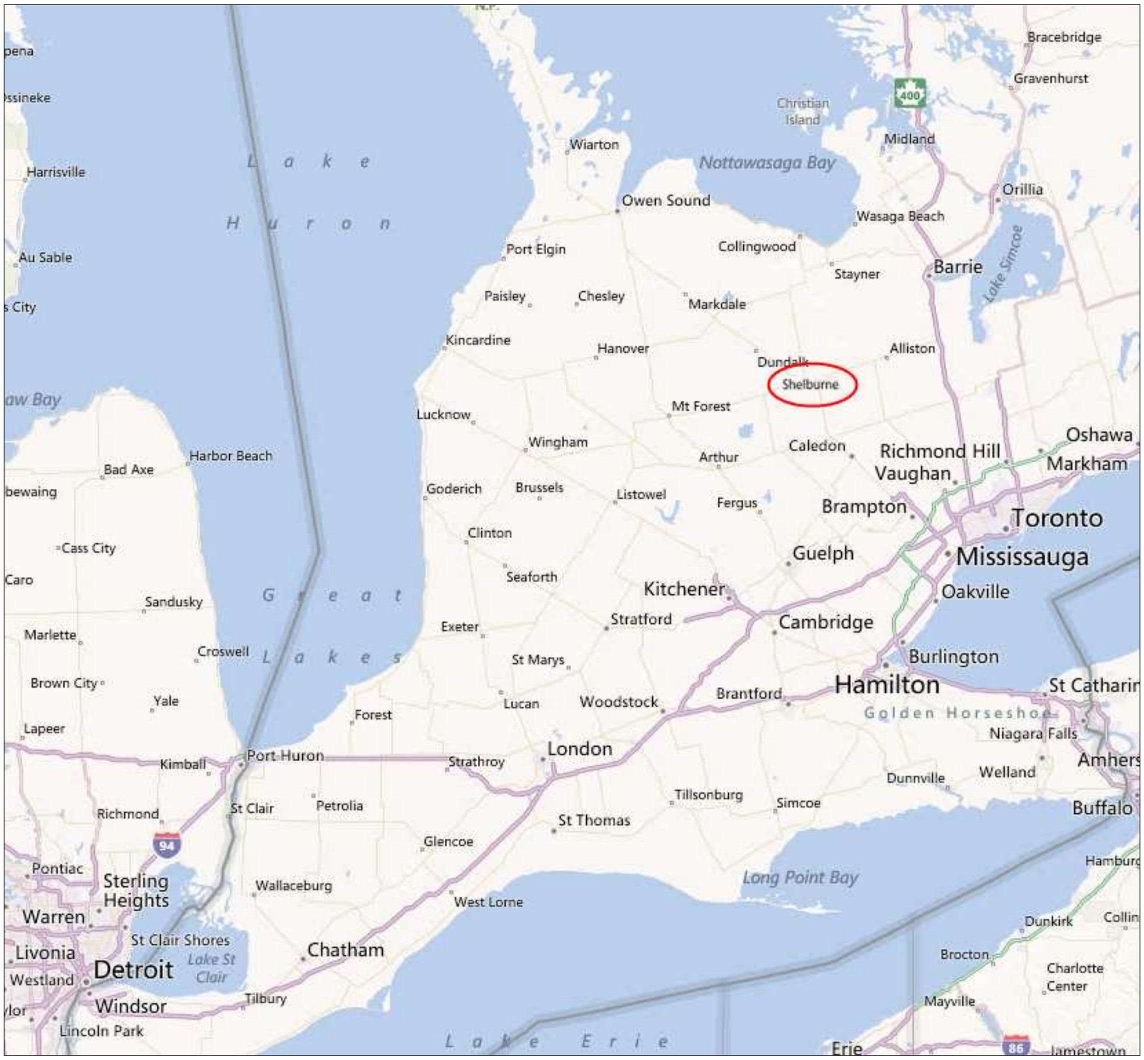
Source: http://www.e-laws.gov.on.ca/html/source/regs/english/2009/elaws_src_regs_r09359_e.htm

It is noted that the "Noise Guidelines for Wind Farms", REQUIRES a proponent to submit a noise report:

> *Proponents of Wind Farms are to prepare and submit to the Ministry of the Environment (MOE) a Noise Assessment Report that includes details of the wind turbine design and operation, location of the wind turbine(s) within the specific site and surrounding area, as well as summary of compliance with the applicable sound level limits.*

The Set-Back table may not apply given a Noise Assessment report is required, why would a setback greater than 550m be used when the guideline requirement is to meet 40 dBA?

Location Map: Shelburne



CASE STUDY: Effects of a Wind Turbine Facility in Melancthon, Ontario

In this case study, an analysis of Melancthon Township properties that sold on the open market during the period 2005 to September 2012 was carried out. A registry search (Ontario's digital registry system) produced several properties that sold in the area, however, for the purpose of this study only 'dwelling properties' with a lot area of between ½ acre and 7½ acres were analyzed. Farm properties were not included.

Canadian Hydro Developers, Inc. purchased five properties, during the 2005 – 2007 time period, and re-sold these properties during the 2009 – 2012 time period. None of the properties detailed in this study had a wind turbine erected on it. Registry facts and MLS® listings for these properties were obtained and the Melancthon Wind Facility and the five properties were inspected in September, 2012.

Did Canadian Hydro Developers, Inc. pay the fair market price?

The sellers may have filed complaints and/or claims that the noises from the turbines were a nuisance and Canadian Hydro Developers, Inc. may have either tried to do the right thing or did not want bad publicity, or both, and purchased the five properties at prices that were in line with market prices for non-turbine homes in the proximity. Other than possible losses and costs resulting from possible litigation, there appears to be no incentive for Canadian Hydro Developers, Inc. to purchase the properties as they were not required for the wind facility.

It is very unlikely that the purchaser, Canadian Hydro Developers, Inc, would give an “equity gift” to a seller which is what Canadian Hydro Developers, Inc. would be doing if it paid above the fair market price.

It is also reasonable to conclude that Canadian Hydro Developers, Inc., a wholly-owned subsidiary of the public company, TransAlta, would not want to be seen as “taking advantage” and would therefore pay the fair market price.

On the following pages, the sale price of twenty dwelling properties in the vicinity of the Melancthon Wind Facility were compared to the sale price of the four dwelling properties purchased by Canadian Hydro Developers, Inc. The fifth property purchased by Canadian Hydro Developers, Inc. was a farm and is not included in this Case Study.

The properties studied were grouped into the following example groups:

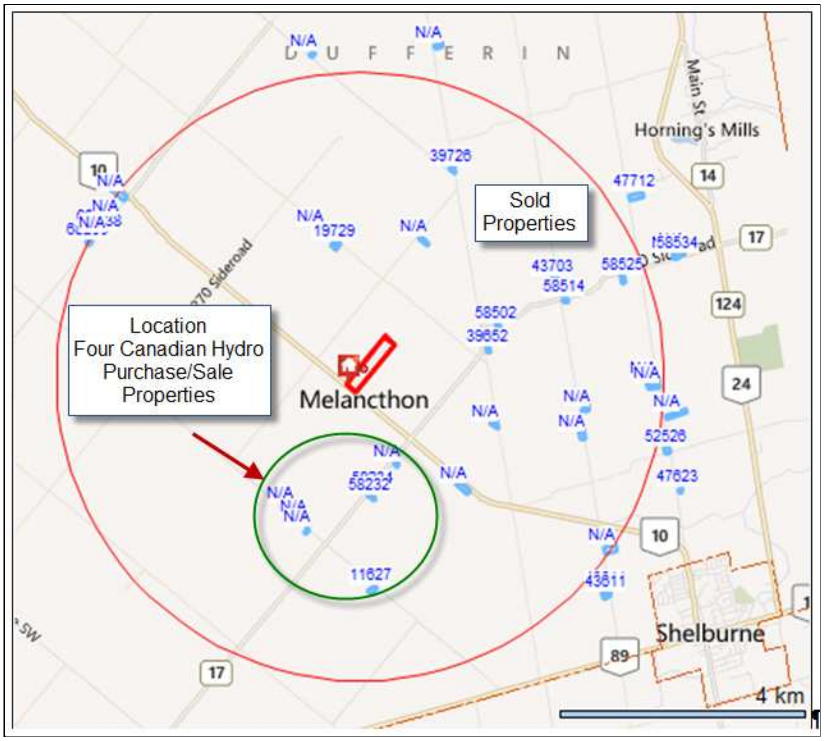
- Example Group A
  Dwelling properties offered and / or listed on MLS® and sold in the open market between January 1, 2005 and December 31, 2007.

- Example Group B
  Dwelling Properties offered and / or listed on MLS® and purchased by Canadian Hydro Developers, Inc. between January 1, 2005 and December 31, 2007 and subsequently re-sold.

The Open Market Sold Price is divided by the above-grade dwelling’s square footage, as provided by Municipal Property Assessment Corporation (MPAC), to obtain the dollar price per square foot. The prices are then compared to the dollar value per square foot paid by Canadian Hydro Developers, Inc.

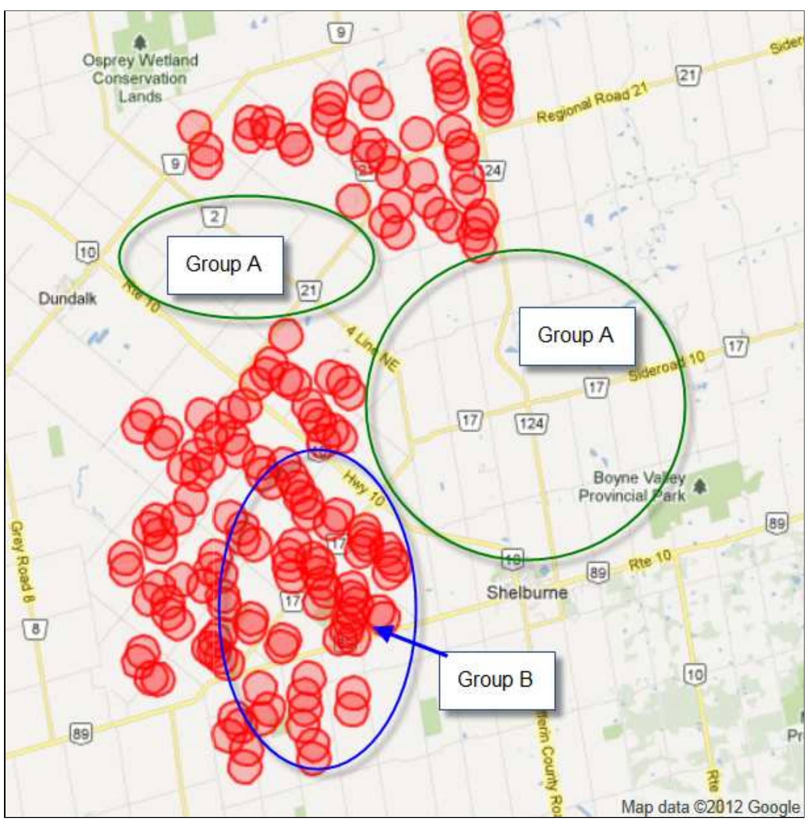
Because the difference between the dollar price per square foot for all the properties is negligible, it is therefore concluded that each of the four properties purchased by Canadian Hydro Developers, Inc. was acquired at a fair open market price.

The following map indicates the approximate location of the properties analyzed.



Source: Ontario's Digital Registry System

The following Map indicates approximate Wind Turbine Locations



Source: http://ontario-wind-turbines.org/owt-maps.html

GROUP A: Open Market Median and Average Sold Prices 2005-2007						
#	**Roll Number**	**Melancthon Address**	**Date Sold**	**Sale Price**	**Dwelling Sq. Ft.**	**$/Sq. Ft.**
1	2219000001253900000	ES Sideroad 280	Aug-05	$295,000	1608	$183.46
2	2219000004010500000	116278 2nd Line	Mar-06	$400,000	2174	$183.99
3	2219000006103250000	43611 4th Line	Apr-06	$326,500	1710	$190.94
4	2219000001192500000	585349 County Rd 17	Oct-06	$270,000	1398	$193.13
5	2219000005165400000	117093 2nd Line	Nov-06	$335,000	1719	$194.88
6	2219000006087200000	ES 4th Line	Apr-06	$333,000	1694	$196.58
7	2219000006076000000	525267 5th Sideroad	May-05	$320,000	1592	$201.01
8	2219000001278200000	397266 5th Line	Feb-06	$315,000	1564	$201.41
9	2219000005006050000	197300 2nd Line	Aug-06	$306,604	1504	$203.86
10	2219000005170030000	SS 2nd Line	Dec-07	$285,500	1392	$205.10
11	2219000006139000000	582400 County Rd 17	Sep-05	$312,500	1508	$207.23
12	2219000006077100000	WS 3rd Line	May-05	$314,019	1500	$209.35
13	2219000006158100000	396428 5th Line	Jul-07	$399,900	1875	$213.28
14	2219000006108500000	43636 4th Line	Feb-06	$309,000	1424	$216.99
15	2219000006061500000	47623 3rd Line	Nov-07	$345,000	1545	$223.30
16	2219000006113500000	39652 5th Line	Jul-07	$409,000	1829	$223.62
17	2219000001189200000	477125 3rd Line	Feb-07	$315,000	1310	$240.46
18	2219000006090100000	43617 4th Line	Feb-06	$384,000	1567	$245.05
19	2219000001217100000	437032 4th Line	Jun-06	$348,000	1400	$248.57
20	2219000006059200000	476353 3rd Line	May-06	$334,900	1320	$253.71
The twenty properties are located in Melancthon just northwest of Shelburne, mostly to the northeast and southeast of the wind turbines facility.				**MEDIAN**		**$206.16**
				AVERAGE		**$211.80**

GROUP B: Purchaser is Canadian Hydro Developers, Inc. Median and Average Sold Prices 2005-2007						
#	**Roll Number**	**Melancthon Address**	**Date Sold**	**Sale Price**	**Dwelling Sq. Ft.**	**$/Sq. Ft.**
a	2219000006138500000	582340 County Rd 17	Aug-07	$302,670	1539	$196.67
b	2219000006138000000	582328 County Rd 17	Jun-05	$299,000	1293	$231.25
c	2208000003215800000	375557 6th Line	Nov-07	$500,000	1887	$264.97
d	2219000004018000000	504059 Highway 89	Jan-07	$305,000	1800	$169.44
These four properties are located south and southwest of the properties in Group A.				**MEDIAN**		**$213.96**
				AVERAGE		**$215.58**

Note: Market value is an estimate, price is an historical fact.

The Median and Average difference between the open market sold price and the Canadian Hydro Developers, Inc. sold price is minimal; therefore, it is reasonable to conclude each purchase by Canadian Hydro Developers, Inc. was at a fair open market price.

When Canadian Hydro Developers, Inc. resold each of the five properties covenants were included in the deed/transfer wherein the buyer waived rights to complain due to noise or other nuisance or living environment issues resulting from wind turbines situated on neighbouring lands.

Each transfer/deed included the following “Transfer of Easement in Gross” covenant:

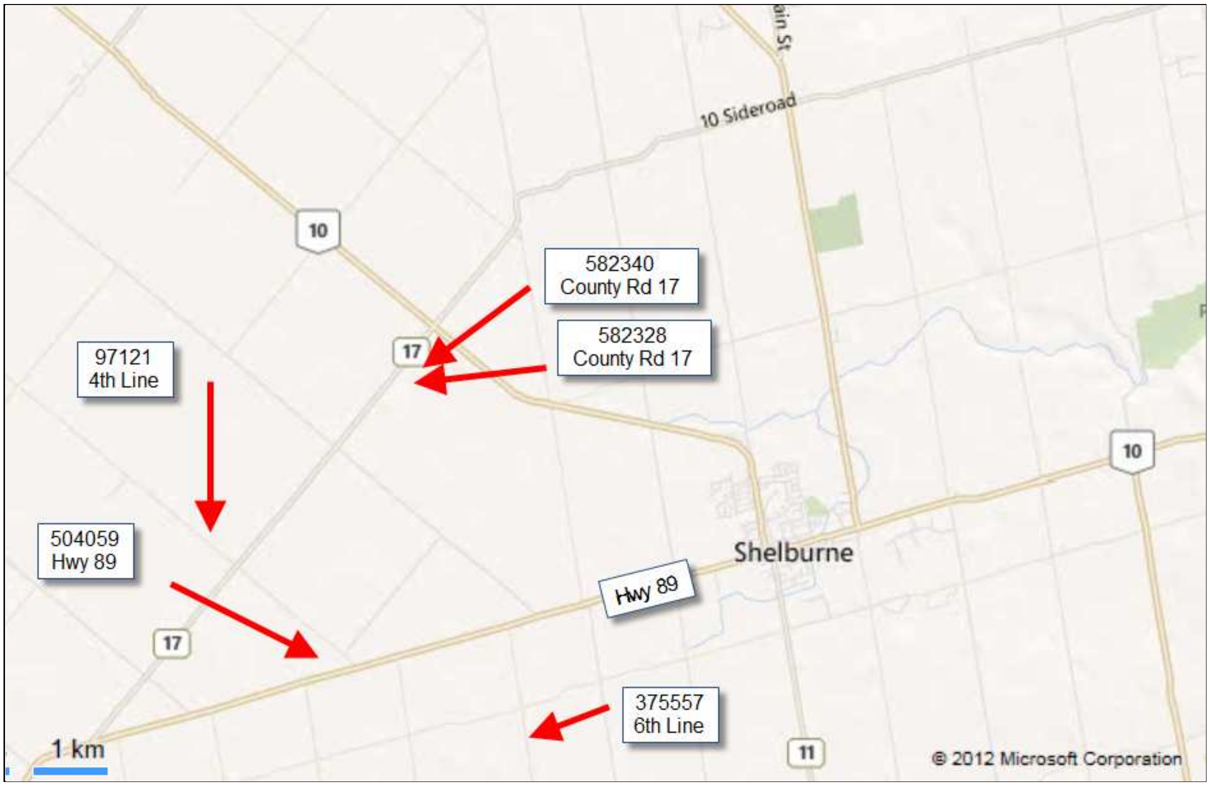
> *“free and unencumbered easement…over, along, and upon the Transferor's Lands for the right and privilege to permit heat, sound, vibration, shadow, flickering of light, noise (including grey noise) or any other adverse effect or combination thereof resulting directly or indirectly from the operation of the Transferee's wind turbine facilities situated…within the Townships of Melancthon and Amaranth, in the County of Dufferin…”.*
>
> *“…The Transferor further acknowledges and agrees that the operation of the Transferee's wind turbine facilities located on the Leasehold Lands may affect the living environment of the Transferor and that the Transferee will not be responsible or liable for, of and from any of the Transferor's complaints, claims, demands, suits, actions, or causes of action of every kind known or unknown which may arise directly or indirectly from the Transferee's wind turbine facilities on the Leasehold Lands to the extent permitted by this Easement”.*
>
> *“In addition, the Transferor hereby covenants and agrees to indemnify, defend, and hold harmless the Transferee from any and all liabilities, claims, demands, costs and expenses arising from any direct, indirect or consequential damages arising out of a complaint, claim, action or cause of action initiated by the Transferor as against the Transferee for anything permitted by this Easement in relation to the Transferee's wind turbine facilities located on the Leasehold Lands”.*

Given that the buyers willingly signed the Transfer of Easement in Gross, the price reflects the fair market resale price.

MELANCTHON PROPERTIES ANALYZED

Having determined that the four properties in Group B were purchased and sold by Canadian Hydro Developers, Inc. at the fair market price, a further analysis was performed to determine whether or not these properties suffered a loss in value.

Each price was adjusted to reflect the passage of time as provided by the Canadian Real Estate Association based on the local real estate MLS® board.



Location of properties purchased and sold by Canadian Hydro Developers, Inc.
Source: Microsoft, altered by Ben Lansink

None of the properties detailed in this study had a wind turbine erected on it.

Sale and Re-Sale: TransAlta Melancthon 133 Wind Turbine Facility			**1**
Property:	375557 6th Line, Amaranth		
	The 1.88 acre site is improved with a single detached dwelling consisting of 1,887 sq. ft.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		771.45	2530.97
Date turbine became operational		Phase I 2006, Phase II 2008	
When sold in November 2007, the average MLS® residential price was $276,285. When the property resold in December 2009 the average MLS® price was $308,063 resulting in a change of 11.5%.	Average MLS® Price November 2007		$276,285
	Average MLS® Price December 2009		$308,063
	$Change		$31,778
	%Change		11.50%
The first buyer, Canadian Hydro Developers, Inc., purchased in November 2007 for $500,000 and would have resold December 2009 for $557,509 when adjusted for the MLS® passage of time.	Actual Sold Price November 2007		$500,000
	% and $ Change	11.50%	$57,509
	Adjusted Price to December 2009		$557,509
The Actual Price when Re-Sold to McDonald in December 2009 was $288,400, a difference of -$269,109.	Actual Re-Sale Price December 2009		$288,400
	$Difference		-$269,109
Diminution in Price: -48.27%.	%Difference		**-48.27%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

This property did NOT have a wind turbine situated on its land. The closest wind turbine was on land situated across the road on land owned by a neighbour. Canadian Hydro Developers, Inc. listed the property on the MLS® system with Royal LePage RCR Realty. It was sold by Re-Max. The selling Realtor® Jerry Snel, was interviewed on January 18, 2012 at 11:30am by Ben Lansink. Mr. Snel estimated the turbine was about 1,000 feet from the dwelling located at 375557 6th Line and he stated:

> *'…when standing next to the house the noise from the turbine was very loud, like the sound of a aircraft…'*.

Property 1 - 375557 6th Line, Amaranth

Source: Ben Lansink

Sale and Re-Sale: TransAlta Melancthon 133 Wind Turbine Facility			**2**
Property:	97121 4th Line, Melancthon		
	The 100.49 acre site is improved with a dwelling and Quonset building.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		579.73	1901.98
Date turbine became operational		Phase I 2006, Phase II 2008	
When sold in October 2007, the average MLS® residential price was $291,323. When the property resold in November 2010 the average MLS® price was $351,479 resulting in a change of 20.65%.	Average MLS® Price October 2007		$291,323
	Average MLS® Price November 2010		$351,479
	$Change		$60,156
	%Change		20.65%
The first buyer, Canadian Hydro Developers, Inc., purchased in October 2007 for $350,000 and would have resold November 2010 for $422,272 when adjusted for the MLS® passage of time.	Actual Sold Price October 2007		$350,000
	% and $ Change	20.65%	$72,272
	Adjusted Price to November 2010		$422,272
The Actual Price when Re-Sold to Bal Farms Ltd in November 2010 was $175,000, a difference of -$247,272.	Actual Re-Sale Price November 2010		$175,000
	$Difference		-$247,272
Diminution in Price: -58.56%.	%Difference		**-58.56%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

It would appear that the dwelling was demolished by Canadian Hydro Developers, Inc. prior to the sale to Bal Farms Ltd.

Property 2 - 97121 4th Line, Melancthon

Source: Ben Lansink

Sale and Re-Sale: TransAlta Melancthon 133 Wind Turbine Facility			**3**
Property:	504059 Highway 89, Melancthon		
	The 10.01 acre site is improved with a single detached dwelling consisting of 1,800 sq. ft.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		202.39	663.99
Date turbine became operational		Phase I 2006, Phase II 2008	
When sold in January 2007, the average MLS® residential price was $254,803. When the property resold in August 2009 the average MLS® price was $302,550 resulting in a change of 18.74%.	Average MLS® Price January 2007		$254,803
	Average MLS® Price August 2009		$302,550
	$Change		$47,747
	%Change		18.74%
The first buyer, Canadian Hydro Developers, Inc., purchased in January 2007 for $305,000 and would have resold August 2009 for $362,153 when adjusted for the MLS® passage of time.	Actual Sold Price January 2007		$305,000
	% and $ Change	18.74%	$57,153
	Adjusted Price to August 2009		$362,153
The Actual Price when Re-Sold to Egresits / Gooder in August 2009 was $278,000, a difference of -$84,153.	Actual Re-Sale Price August 2009		$278,000
	$Difference		-$84,153
Diminution in Price: -23.24%.	%Difference		**-23.24%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

Property 3 - 504059 Highway 89, Melancthon

Source: Ben Lansink

Sale and Re-Sale: TransAlta Melancthon 133 Wind Turbine Facility			**4**
Property:	582340 County Road 17, Melancthon		
	The 1.00 acre site is improved with a single detached dwelling consisting of 1,539 sq. ft.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		346.25	1135.99
Date turbine became operational		Phase I 2006, Phase II 2008	
When sold in August 2007, the average MLS® residential price was $317,478. When the property resold in April 2010 the average MLS® price was $307,515 resulting in a change of -3.14%.	Average MLS® Price August 2007		$317,478
	Average MLS® Price April 2010		$307,515
	$Change		-$9,963
	%Change		-3.14%
The first buyer, Canadian Hydro Developers, Inc., purchased in August 2007 for $302,670 and would have resold April 2010 for $293,172 when adjusted for the MLS® passage of time.	Actual Sold Price August 2007		$302,670
	% and $ Change	-3.14%	-$9,498
	Adjusted Price to April 2010		$293,172
The Actual Price when Re-Sold to Armstrong in April 2010 was $215,000, a difference of -$78,172.	Actual Re-Sale Price April 2010		$215,000
	$Difference		-$78,172
Diminution in Price: -26.66%.	%Difference		**-26.66%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

Property 4 - 582340 County Road 17, Melancthon

Source: Ben Lansink

Caution to the Wind
Updated Sat. Dec. 27 2008 6:55 PM ET

W-FIVE Staff

Portions of the News Report Follow:

Helen Fraser wasn't at the opening of the Melancthon EcoPower Centre. But she's all-too familiar with the turbines. According to Fraser, she and her husband lived just over 400 meters from one of the turbines erected in phase one of the project. At first she had no problem with the fact that a wind farm was coming to her rural area.
"I thought this was absolutely amazing. [I was] all for green" said Fraser. But soon after the 45 meter blades -- longer than the wingspan of a Boeing 737 -- started spinning, she said she knew something was wrong.

"It was like a whoosh sound. It would just go whoosh-whoosh, like a steady beat with it. And there would be times my heart would actually beat to the pulse of the turbine," she recalled.

Even though the turbines' distance from the Fraser's home satisfied the Ontario government's noise guidelines, the sound and strobing effect when the sun was shining through the spinning blades made them too close for comfort - at least for the Frasers.

"I had terrible headaches, body aches. I couldn't sleep at night," said Fraser. "My husband's blood sugar, because he has diabetes, was all over the map." When the couple went away on vacation, they say the problems stopped.

Fraser and her family eventually sold their property to Canadian Hydro Developers, the company behind the wind farm, and their former home sits in the shadow of a giant, spinning wind turbine.

Source: W-FIVE Staff

Sale and Re-Sale: TransAlta Melancthon 133 Wind Turbine Facility			**5**
Property:	582328 County Road 17, Melancthon		
	The 2.08 acre site is improved with a single detached dwelling consisting of 1,293 sq. ft.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		369.72	1212.99
Date turbine became operational		Phase I 2006, Phase II 2008	
When sold in June 2005, the average MLS® residential price was $279,707. When the property resold in June 2012 the average MLS® price was $372,995 resulting in a change of 33.35%.	Average MLS® Price June 2005		$279,707
	Average MLS® Price June 2012		$372,995
	$Change		$93,288
	%Change		33.35%
The first buyer, Canadian Hydro Developers, Inc., purchased in June 2005 for $299,000 and would have resold June 2012 for $398,723 when adjusted for the MLS® passage of time.	Actual Sold Price June 2005		$299,000
	% and $ Change	33.35%	$99,723
	Adjusted Price to June 2012		$398,723
The Actual Price when Re-Sold to Steffan in June 2012 was $250,000, a difference of -$148,723.	Actual Re-Sale Price June 2012		$250,000
	$Difference		-$148,723
Diminution in Price: -37.30%.	%Difference		**-37.30%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

Property 5 - 582328 County Road 17, Melancthon

Source: Ben Lansink

In each of the five sales, Canadian Hydro Developers, Inc. registered a "Transfer of Easement in Gross".

Following is an example of a typical easement.

SCHEDULE

TRANSFER OF EASEMENT IN GROSS

Transferor: **Malcolm Keith McDonald**
Transferee: **Canadian Hydro Developers, Inc.**
Re: **Part Lot 29, Concession 5, Part 1 on Plan 7R787, Amaranth (PIN: 34055-0033 (LT))**

The Transferor hereby transfers, sells, grants, and conveys to the Transferee, to use and enjoy for the benefit of the Transferee, the right, liberty, privilege, and free and unencumbered easement (hereinafter "Easement") in perpetuity commencing on the date hereof, over, along, and upon the Transferor's Lands for the right and privilege to permit heat, sound, vibration, shadow, flickering of light, noise (including grey noise) or any other adverse effect or combination thereof resulting directly or indirectly from the operation of the Transferee's wind turbine facilities situated on the Transferee's leasehold interests located within the Townships of Melancthon and Amaranth, in the County of Dufferin, for the Transferee's Melancthon EcoPower Centre, which shall include but not be limited to any and all options to lease and lease agreements and any renewals, extensions, amendments or replacements thereof, in any abutting, adjoining, neighbouring or other lands (hereinafter, collectively, the 'Leasehold Lands'). The Transferor further acknowledges and agrees that the operation of the Transferee's wind turbine facilities located on the Leasehold Lands may affect the living environment of the Transferor and that the Transferee will not be responsible or liable for, of and from any of the Transferor's complaints, claims, demands, suits, actions, or causes of action of every kind known or unknown which may arise directly or indirectly from the Transferee's wind turbine facilities on the Leasehold Lands to the extent permitted by this Easement. In addition, the Transferor hereby covenants and agrees to indemnify, defend, and hold harmless the Transferee from any and all liabilities, claims, demands, costs and expenses arising from any direct, indirect or consequential damages arising out of a complaint, claim, action or cause of action initiated by the Transferor as against the Transferee for anything permitted by this Easement in relation to the Transferee's wind turbine facilities located on the Leasehold Lands.

This Easement and all acknowledgements contained herein shall enure to the benefit of and be binding upon the Transferor and Transferee and their respective heirs, executors, successors, servants, agents and assigns, as the case may be. This Easement will also be registered on title and shall remain with the Transferor's Lands.

This is an easement in gross.

Source: Attachment to Deed DC105449

CONCLUSIONS – Melancthon Property Purchases and Re-Sales

Market evidence suggests that 'dwelling properties' will be harmed or injured by the construction, use, and maintenance of wind turbines situated on properties located in the vicinity. Real or perceived nuisances resulting from wind turbines produces buyer resistance that results in price diminution.

TransAlta Melancthon 133 Wind Turbine Facility		
1	375557 6th Line, Amaranth	-48.27%
2	97121 4th Line, Melancthon	-58.56%
3	504059 Highway 89, Melancthon	-23.24%
4	582340 County Road 17, Melancthon	-26.66%
5	582328 County Road 17, Melancthon	-37.30%
Median Price Diminution		**-37.30%**
Average Price Diminution		**-38.81%**
Low		**-23.24%**
High		**-58.56%**

The erection of a wind turbine creates apprehension in the general public, which makes the property less desirable and thus diminishes the prices of neighbouring property. Continuing scientific uncertainty over the adverse health consequences of wind turbines only serves to perpetuate the debilitating effect of wind turbines on property prices.

By including the Transfer of Easement in Gross in the deed/transfer of the properties sold by Canadian Hydro Developers, Inc., it is reasonable to conclude that Canadian Hydro Developers, Inc. was fully aware of problems associated with…h*eat, sound, vibration, shadow, flickering of light, noise (including grey noise) or any other adverse effect or combination thereof resulting directly or indirectly from the operation of the Transferee's wind turbine facilities situated…within the Townships of Melancthon and Amaranth, in the County of Dufferin…'* and that the turbines *…'**may affect the living environment'**…".*

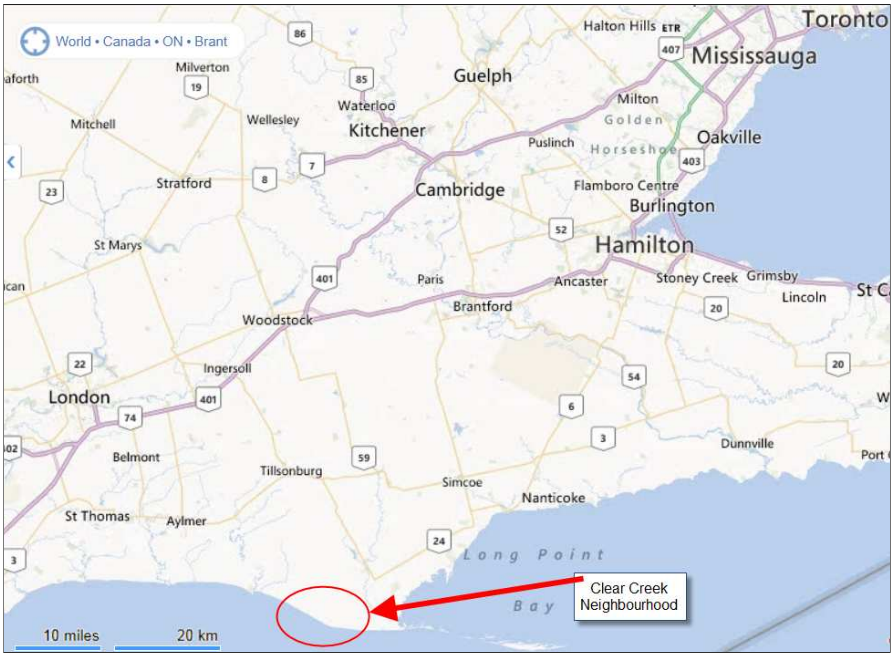
The covenants imposed by Canadian Hydro Developers, Inc. and accepted by the five buyers suggest an official admission by Canadian Hydro Developers, Inc. that there are living environment issues with the result that there is a diminution in price as a result of wind turbines.

It is also reasonable to assume that a property that has a wind turbine erected on it will suffer a similar price diminution and will be injuriously affected.

The Clear Creek Wind turbine facility, also known as "Frogmore-Cultus-Clear Creek", consists of about 18 Wind Turbines. The Clear Creek Wind Facility project became operational on November 22, 2008.

Lakeshore Road, Clear Creek, Ontario, Canada. Photograph: Ben Lansink

Location Map: Clear Creek, Ontario



CASE STUDY: Effects of a Wind Turbine Facility in Clear Creek, Ontario

In this case study, an analysis of the Clear Creek neighbourhood properties that sold on the open market was carried out. A registry search (Ontario's digital registry system) produced several properties that sold in the area, however, for the purpose of this study only 'dwelling properties' and a vacant bush site were analyzed. Farm properties were not included.

Two properties sold and re-sold. Property 1 sold March 2004 and re-sold May 2012. Property 2 sold September 1995 and re-sold March 2012.

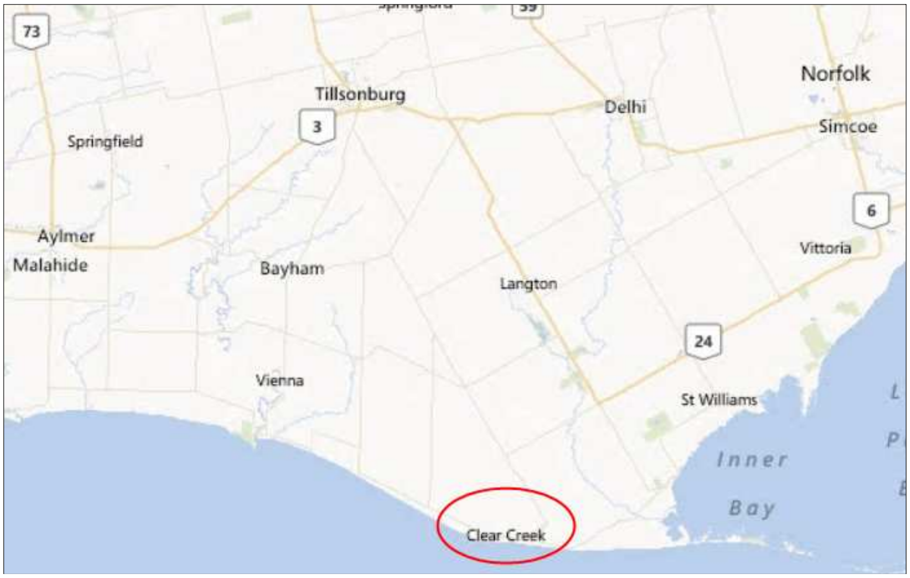
Properties 3-7 had "Current Value" assessments as of January 1, 2008 in place as estimated by the Municipal Property Assessment Corporation (MPAC). The sold dates for these properties are from October 2010 to September 2012.

None of the properties considered in this report had a wind turbine erected on it.

Registry facts and MLS® listings (if available) for these properties were obtained and are on file.

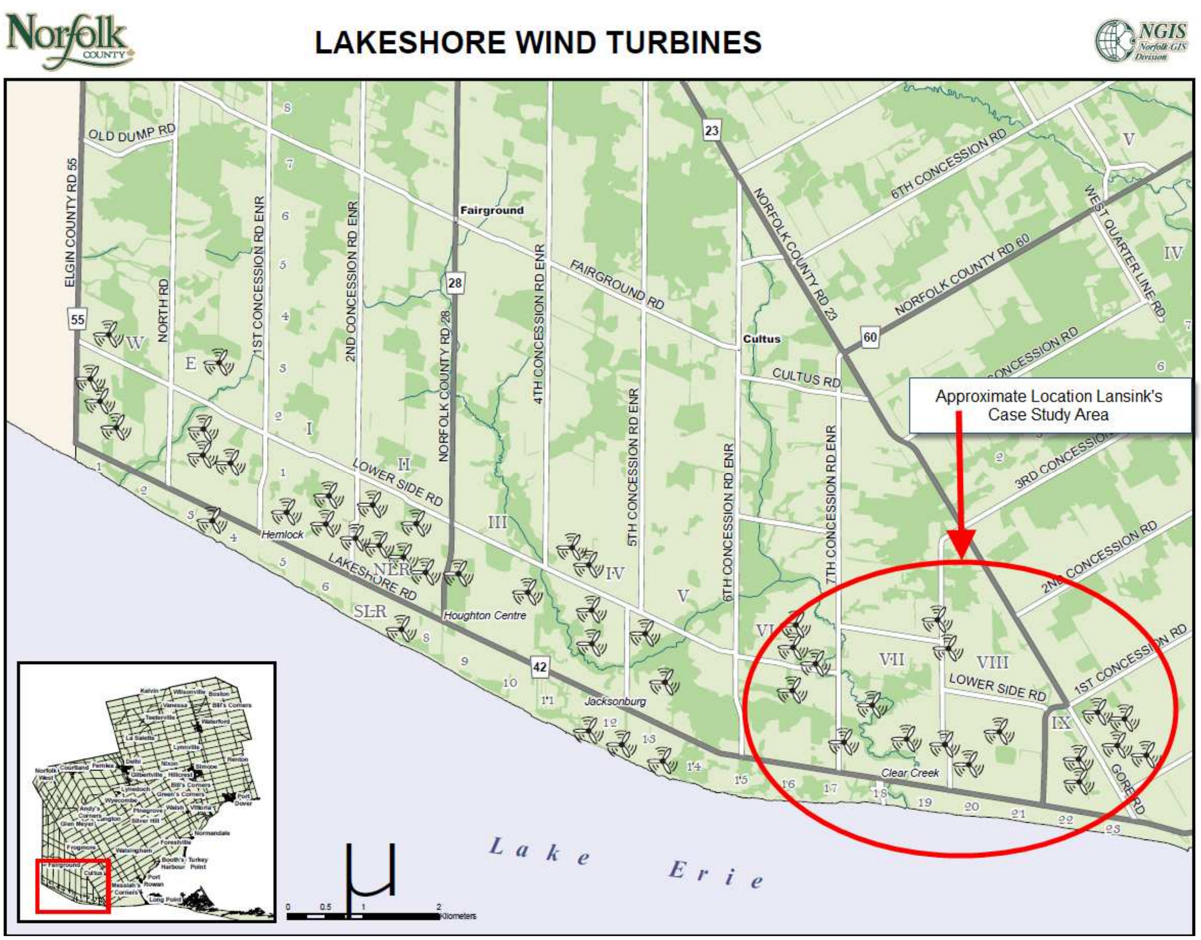
The Clear Creek properties and neighbourhood were inspected and photographed by Ben Lansink on October 9, 2012.

The following map indicates the location of Clear Creek



Source: http://www.bing.com/maps/

The following Map indicates approximate Clear Creek Wind Turbine Locations



Source: Norfolk County

Property 1 - 1480 Lakeshore Road, Norfolk

Sale and Re-Sale: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			**1**
Property:	1480 Lakeshore Road, Norfolk		
	The 1.02 acre site is improved with a single detached dwelling consisting of 1,017 sq. ft.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		464.00	1522.29
Date turbine became operational		Nov 22, 2008	
When sold in March 2004, the average MLS® residential price was $138,668. When the property resold in May 2012 the average MLS® price was $237,895 resulting in a change of 71.56%.	Average MLS® Price March 2004		$138,668
	Average MLS® Price May 2012		$237,895
	$Change		$99,227
	%Change		71.56%
The first buyer, Kaiss / Steverson, purchased in March 2004 for $71,000 and would have resold May 2012 for $121,806 when adjusted for the MLS® passage of time.	Actual Sold Price March 2004		$71,000
	% and $ Change	71.56%	$50,806
	Adjusted Price to May 2012		$121,806
The Actual Price when Re-Sold to Weber in May 2012 was $68,000, a difference of -$53,806.	Actual Re-Sale Price May 2012		$68,000
	$Difference		-$53,806
Diminution in Price: -44.17%.	%Difference		**-44.17%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		

Property 1 - 1480 Lakeshore Road, Norfolk

Source: Ben Lansink

Sale and Re-Sale: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			**2**
Property:	71 Norfolk County Road 23, Norfolk		
	The 1.13 acre site is improved with a single detached dwelling consisting of 1,659 sq. ft.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		464.00	1522.29
Date turbine became operational		Nov 22, 2008	
When sold in September 1995, the average MLS® residential price was $106,911. When the property resold in March 2012 the average MLS® price was $214,070 resulting in a change of 100.23%.	Average MLS® Price 1995		$106,911
	Average MLS® Price March 2012		$214,070
	$Change		$107,159
	%Change		100.23%
The first buyer, Braun, purchased in September 1995 for $78,000 and would have resold March 2012 for $156,181 when adjusted for the MLS® passage of time.	Actual Sold Price September 1995		$78,000
	% and $ Change	100.23%	$78,181
	Adjusted Price to March 2012		$156,181
The Actual Price when Re-Sold to Powell / Wedekind in March 2012 was $70,000, a difference of -$86,181.	Actual Re-Sale Price March 2012		$70,000
	$Difference		-$86,181
Diminution in Price: -55.18%.	%Difference		**-55.18%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		

Property 2 - 71 Norfolk County Road 23, Norfolk

Source: Ben Lansink

Municipal Property Assessment Corporation Current Value* vs. Actual Sold Price			3
Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			
Property	47 Concession Road A, Norfolk		
	The 1.01 acre site is improved with a single detached dwelling consisting of 1,934 sq. ft.		
Turbine distance to dwelling (estimated by aerial map scaling)		Metres	Feet
		391.00	1282.79
Date turbine became operational		Nov 22, 2008	
When valued by MPAC on January 2008, the average residential price was $199,418. When the property sold in July 2012 the average MLS® price was $225,259 resulting in a change of 12.96%.	Average MLS® Price January, 2008		$199,418
	Average MLS® Price July 2012		$225,259
	$Change		$25,841
	%Change		12.96%
The MPAC January 2008 Current Market Value was $153,000 but the Current Market Value as of July 2012 would be $172,826.06 when adjusted for the MLS® passage of time.	Actual Sold Price January 2008		$153,000
	% and $ Change	12.96%	$19,826
	Adjusted Price to July 2012		$172,826
The Actual Price when Sold to Hunt in July 2012 was $134,000, a difference of -$38,826.	Actual Re-Sale Price July 2012		$134,000
	$Difference		-$38,826
Diminution in Price: -22.47%.	%Difference		**-22.47%**
Passage of Time Source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		
**Assessment Act*, R.S.O. 1990, CHAPTER A.31, 1. Definitions: "current value" means, in relation to land, the amount of money the fee simple, if unencumbered, would realize if sold at arm's length by a willing seller to a willing buyer; ("valeur actuelle")			

Property 3 - 47 Concession Road A, Norfolk

Source: Ben Lansink

Municipal Property Assessment Corporation Current Value* vs. Actual Sold Price			4
Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			
Property	43 Old Mill Road, Norfolk		
	The .55 acre site is improved with a single detached dwelling consisting of 1,158 sq. ft.		
Turbine distance to dwelling (estimated by aerial map scaling)		Metres	Feet
		647.00	2122.68
Date turbine became operational		Nov 22, 2008	
When valued by MPAC on January 2008, the average residential price was $199,418. When the property sold in June 2012 the average MLS® price was $213,873 resulting in a change of 7.25%.	Average MLS® Price January, 2008		$199,418
	Average MLS® Price June 2012		$213,873
	$Change		$14,455
	%Change		7.25%
The MPAC January 2008 Current Market Value was $153,000 but the Current Market Value as of June 2012 would be $164,090.35 when adjusted for the MLS® passage of time.	Actual Sold Price January 2008		$153,000
	% and $ Change	7.25%	$11,090
	Adjusted Price to June 2012		$164,090
The Actual Price when Sold to Fidanza in June 2012 was $110,000, a difference of -$54,090.	Actual Re-Sale Price June 2012		$110,000
	$Difference		-$54,090
Diminution in Price: -32.96%.	%Difference		**-32.96%**
Passage of Time Source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		
**Assessment Act*, R.S.O. 1990, CHAPTER A.31, 1. Definitions: “current value” means, in relation to land, the amount of money the fee simple, if unencumbered, would realize if sold at arm’s length by a willing seller to a willing buyer; (“valeur actuelle”)			

Property 4 - 43 Old Mill Road, Norfolk

Source: Ben Lansink

Municipal Property Assessment Corporation Current Value* vs. Actual Sold Price			5
Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			
Property	1575 Lakeshore Road, Norfolk		
	The 2.62 acre site is improved with a single detached dwelling consisting of 1,245 sq. ft.		
Turbine distance to dwelling (estimated by aerial map scaling)		Metres	Feet
		606.00	1988.16
Date turbine became operational		Nov 22, 2008	
When valued by MPAC on January 2008, the average residential price was $199,418. When the property sold in November 2010 the average MLS® price was $214,434 resulting in a change of 7.53%.	Average MLS® Price January, 2008		$199,418
	Average MLS® Price November 2010		$214,434
	$Change		$15,016
	%Change		7.53%
The MPAC January 2008 Current Market Value was $225,000 but the Current Market Value as of November 2010 would be $241,942.30 when adjusted for the MLS® passage of time.	Actual Sold Price January 2008		$225,000
	% and $ Change	7.53%	$16,942
	Adjusted Price to November 2010		$241,942
The Actual Price when Sold to Flower / Willbanks in November 2010 was $175,000, a difference of -$66,942.	Actual Re-Sale Price November 2010		$175,000
	$Difference		-$66,942
Diminution in Price: -27.67%.	%Difference		**-27.67%**
Passage of Time Source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		
**Assessment Act*, R.S.O. 1990, CHAPTER A.31, 1. Definitions: “current value” means, in relation to land, the amount of money the fee simple, if unencumbered, would realize if sold at arm’s length by a willing seller to a willing buyer; (“valeur actuelle”)			

Property 5 - 1575 Lakeshore Road, Norfolk

Source: Ben Lansink

Municipal Property Assessment Corporation Current Value* vs. Actual Sold Price			6
Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			
Property	1527 Lakeshore Road, Norfolk		
	The 6.13 acre site is improved with a single detached dwelling consisting of 1,154 sq. ft.		
Turbine distance to dwelling (estimated by aerial map scaling)		Metres	Feet
		606.00	1988.16
Date turbine became operational		Nov 22, 2008	
When valued by MPAC on January 2008, the average residential price was $199,418. When the property sold in October 2010 the average MLS® price was $218,496 resulting in a change of 9.57%.	Average MLS® Price January, 2008		$199,418
	Average MLS® Price October 2010		$218,496
	$Change		$19,078
	%Change		9.57%
The MPAC January 2008 Current Market Value was $231,000 but the Current Market Value as of October 2010 would be $253,099.40 when adjusted for the MLS® passage of time.	Actual Sold Price January 2008		$231,000
	% and $ Change	9.57%	$22,099
	Adjusted Price to October 2010		$253,099
The Actual Price when Sold to Flower / Pearlman in October 2010 was $180,000, a difference of -$73,099.	Actual Re-Sale Price October 2010		$180,000
	$Difference		-$73,099
Diminution in Price: -28.88%.	%Difference		**-28.88%**
Passage of Time Source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		
**Assessment Act*, R.S.O. 1990, CHAPTER A.31, 1. Definitions: “current value” means, in relation to land, the amount of money the fee simple, if unencumbered, would realize if sold at arm’s length by a willing seller to a willing buyer; (“valeur actuelle”)			

Property 6 - 1527 Lakeshore Road, Norfolk

Source: Ben Lansink

<table>
<tr><td colspan="3">Municipal Property Assessment Corporation Current Value* vs. Actual Sold Price</td><td>7</td></tr>
<tr><td colspan="4">Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines</td></tr>
<tr><td rowspan="2">Property</td><td colspan="3">1921 Lakeshore Road, Norfolk</td></tr>
<tr><td colspan="3">The 24.72 acre site is vacant rural bush land.</td></tr>
<tr><td colspan="2" rowspan="2">Turbine distance to Lot (estimated by aerial map scaling)</td><td>Metres</td><td>Feet</td></tr>
<tr><td>51.82</td><td>170.01</td></tr>
<tr><td colspan="2">Date turbine became operational</td><td colspan="2">Nov 22, 2008</td></tr>
<tr><td rowspan="4">When valued by MPAC on January 2008, the average residential price was $199,418. When the property sold in September 2012 the average MLS® price was $208,155 resulting in a change of 4.38%.</td><td colspan="2">Average MLS® Price January, 2008</td><td>$199,418</td></tr>
<tr><td colspan="2">Average MLS® Price September 2012</td><td>$208,155</td></tr>
<tr><td colspan="2">$Change</td><td>$8,737</td></tr>
<tr><td colspan="2">%Change</td><td>4.38%</td></tr>
<tr><td rowspan="3">The MPAC January 2008 Current Market Value was $109,000 but the Current Market Value as of September 2012 would be $113,775.56 when adjusted for the MLS® passage of time.</td><td colspan="2">Actual Sold Price January 2008</td><td>$109,000</td></tr>
<tr><td>% and $ Change</td><td>4.38%</td><td>$4,776</td></tr>
<tr><td colspan="2">Adjusted Price to September 2012</td><td>$113,776</td></tr>
<tr><td rowspan="2">The Actual Price when Sold to Serra in September 2012 was $70,000, a difference of -$43,776.</td><td colspan="2">Actual Re-Sale Price September 2012</td><td>$70,000</td></tr>
<tr><td colspan="2">$Difference</td><td>-$43,776</td></tr>
<tr><td>Diminution in Price: -38.48%.</td><td colspan="2">%Difference</td><td>-38.48%</td></tr>
<tr><td>Passage of Time Source:</td><td colspan="3">The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.</td></tr>
<tr><td colspan="4">*Assessment Act, R.S.O. 1990, CHAPTER A.31, 1. Definitions:
“current value” means, in relation to land, the amount of money the fee simple, if unencumbered, would realize if sold at arm’s length by a willing seller to a willing buyer; (“valeur actuelle”)</td></tr>
</table>

Source: Ben Lansink

CONCLUSIONS – Current Values, Property Purchases and Re-Sales

Market evidence suggests that ‘dwelling properties’ will be harmed or injured by the construction, use, and maintenance of wind turbines situated in the vicinity. Real or perceived nuisances resulting from wind turbines produces buyer resistance that results in price diminution.

Conclusion: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines		
1	1480 Lakeshore Road, Norfolk	-44.17%
2	71 Norfolk County Road 23, Norfolk	-55.18%
3	47 Concession Road A, Norfolk	-22.47%
4	43 Old Mill Road, Norfolk	-32.96%
5	1575 Lakeshore Road, Norfolk	-27.67%
6	1527 Lakeshore Road, Norfolk	-28.88%
7	1921 Lakeshore Road, Norfolk	-38.48%
	Median	**-32.96%**
	Average	**-35.69%**
	Low	**-22.47%**
	High	**-55.18%**

None of the above properties had a Wind Turbine situated on its land.

The Wind Turbines were located in the neighbourhood.

However, it is reasonable to assume that a property that has a wind turbine erected on it will suffer a similar price diminution and will also be injuriously affected.

The Future: Given that wind turbines are a relatively new phenomenon in Ontario (since 2006), it may be that in the future a buyer will simply refuse to purchase a property within the vicinity of a wind turbine. If there is no buyer, there may be no value.

Municipal Property Assessment Corporation (MPAC) Changes

The valuation system used by MPAC is based on current value assessment (CVA).

> "current value" means, in relation to land, the amount of money the fee simple, if unencumbered, would realize if sold at arm's length by a willing seller to a willing buyer; ("valeur actuelle")

Source: Assessment Act, R.S.O. 1990, CHAPTER A.31

The primary valuation tool within the Computer Assisted Mass Appraisal is *Multiple Regression Analysis*, a statistical tool used by assessing authorities to automate the sales comparison approach to value in a mass appraisal setting.

All property in Ontario is assessed once every four years by MPAC. Each property is assessed based on what a willing buyer would pay a willing seller for the property on a legislated valuation date.

In Ontario's four-year assessment cycle, a province-wide Assessment Update has taken place in the fall 2012, effective for the 2013-2016 property tax years, and is based on a legislated valuation date of January 1, 2012.

Assessment Cycle Chart

PROPERTY TAXATION YEAR(S)	YEAR IN WHICH ASSESSED VALUE WAS/WILL BE UPDATED TO REFLECT MARKET CHANGE	LEGISLATED VALUATION DATE (ASSESSED VALUE CALCULATED AS OF...)
2003	2002	June 30, 2001
2004 2005	2003	June 30, 2003
2006 2007 2008	2005	January 1, 2005
2009 **2010** **2011** **2012**	**2008**	**January 1, 2008**
2013 2014 2015 2016	2012	January 1, 2012

This Study considered 20 properties, CV 1 – CV 20, each located within the influence of a Wind Turbine or turbines. There are no other obvious facts to suggest that the Current Value Assessments should be lowered.

Project: TransAlta Melancthon 133 Wind Turbine Facility			CV 1
Property:	375557 6th Line, Amaranth		
	The 1.88 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		771.45	2530.973
Date turbine became operational		Phase I 2006, Phase II 2008	
On January 1, 2008, the average MLS® residential price was $270,227. On January 1, 2012, the average MLS® price was $307,335 resulting in a change of 13.73%.	Average MLS® Price Jan 01, 2008		$270,227
	Average MLS® Price Jan 01, 2012		$307,335
	$Change		$37,108
	%Change		13.73%
The January 1, 2008 Current Value of $293,000 would be $333,235 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$293,000
	% and $ Change	13.73%	$40,235
	Adjusted Current Value to Jan 2012		$333,235
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $331,000, a difference of -$2,235.	Current Value Jan 01, 2012		$331,000
	$Difference		-$2,235
Change in Current Value: -.67%.	%Difference		**-0.67%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

Project: TransAlta Melancthon 133 Wind Turbine Facility			CV 2
Property:	504059 Highway 89, Melancthon		
	The 10.12 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		202.39	663.992
Date turbine became operational		Phase I 2006, Phase II 2008	
On January 1, 2008, the average MLS® residential price was $270,227. On January 1, 2012, the average MLS® price was $307,335 resulting in a change of 13.73%.	Average MLS® Price Jan 01, 2008		$270,227
	Average MLS® Price Jan 01, 2012		$307,335
	$Change		$37,108
	%Change		13.73%
The January 1, 2008 Current Value of $267,000 would be $303,665 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$267,000
	% and $ Change	13.73%	$36,665
	Adjusted Current Value to Jan 2012		$303,665
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $296,000, a difference of -$7,665.	Current Value Jan 01, 2012		$296,000
	$Difference		-$7,665
Change in Current Value: -2.52%.	%Difference		**-2.52%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

Project: TransAlta Melancthon 133 Wind Turbine Facility			CV 3
Property:	582340 County Road 17, Melancthon		
	The 1.00 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		346.25	1135.986
Date turbine became operational		Phase I 2006, Phase II 2008	
On January 1, 2008, the average MLS® residential price was $270,227. On January 1, 2012, the average MLS® price was $307,335 resulting in a change of 13.73%.	Average MLS® Price Jan 01, 2008		$270,227
	Average MLS® Price Jan 01, 2012		$307,335
	$Change		$37,108
	%Change		13.73%
The January 1, 2008 Current Value of $290,000 would be $329,823 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$290,000
	% and $ Change	13.73%	$39,823
	Adjusted Current Value to Jan 2012		$329,823
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $305,000, a difference of -$24,823.	Current Value Jan 01, 2012		$305,000
	$Difference		-$24,823
Change in Current Value: -7.53%.	%Difference		**-7.53%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Orangeville & District MLS® board.		

Project: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			CV 4
Property:	1480 Lakeshore Road, Norfolk (Clear Creek)		
	The .84 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		464.00	1522.291
Date turbine became operational		Nov 22, 2008	
On January 1, 2008, the average MLS® residential price was $189,279. On January 1, 2012, the average MLS® price was $213,232 resulting in a change of 12.65%.	Average MLS® Price Jan 01, 2008		$189,279
	Average MLS® Price Jan 01, 2012		$213,232
	$Change		$23,953
	%Change		12.65%
The January 1, 2008 Current Value of $200,000 would be $225,310 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$200,000
	% and $ Change	12.65%	$25,310
	Adjusted Current Value to Jan 2012		$225,310
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $145,000, a difference of -$80,310.	Current Value Jan 01, 2012		$145,000
	$Difference		-$80,310
Change in Current Value: -35.64%.	%Difference		**-35.64%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		

Project: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines		**CV 5**
Property:	71 Norfolk County Road 23, Norfolk (Clear Creek)	
	The .87 acre site is improved with a single detached dwelling.	
Turbine Distance to Dwelling (estimated by aerial map scaling)	Metres	Feet
	464.00	1522.291
Date turbine became operational	Nov 22, 2008	
On January 1, 2008, the average MLS® residential price was $189,279. On January 1, 2012, the average MLS® price was $213,232 resulting in a change of 12.65%.	Average MLS® Price Jan 01, 2008	$189,279
	Average MLS® Price Jan 01, 2012	$213,232
	$Change	$23,953
	%Change	12.65%
The January 1, 2008 Current Value of $124,000 would be $139,692 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008	$124,000
	% and $ Change 12.65%	$15,692
	Adjusted Current Value to Jan 2012	$139,692
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $119,000, a difference of -$20,692.	Current Value Jan 01, 2012	$119,000
	$Difference	-$20,692
Change in Current Value: -14.81%.	%Difference	**-14.81%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.	

Project: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines		**CV 6**
Property:	43 Old Mill Road, Norfolk (Clear Creek)	
	The .54 acre site is improved with a single detached dwelling.	
Turbine Distance to Dwelling (estimated by aerial map scaling)	Metres	Feet
	647.00	2122.678
Date turbine became operational	Nov 22, 2008	
On January 1, 2008, the average MLS® residential price was $189,279. On January 1, 2012, the average MLS® price was $213,232 resulting in a change of 12.65%.	Average MLS® Price Jan 01, 2008	$189,279
	Average MLS® Price Jan 01, 2012	$213,232
	$Change	$23,953
	%Change	12.65%
The January 1, 2008 Current Value of $153,000 would be $172,362 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008	$153,000
	% and $ Change 12.65%	$19,362
	Adjusted Current Value to Jan 2012	$172,362
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $123,000, a difference of -$49,362.	Current Value Jan 01, 2012	$123,000
	$Difference	-$49,362
Change in Current Value: -28.64%.	%Difference	**-28.64%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.	

Project: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			**CV 7**
Property:	1575 Lakeshore Road, Norfolk (Clear Creek)		
	The 2.40 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		606.00	1988.165
Date turbine became operational		Nov 22, 2008	
On January 1, 2008, the average MLS® residential price was $189,279. On January 1, 2012, the average MLS® price was $213,232 resulting in a change of 12.65%.	Average MLS® Price Jan 01, 2008		$189,279
	Average MLS® Price Jan 01, 2012		$213,232
	$Change		$23,953
	%Change		12.65%
The January 1, 2008 Current Value of $225,000 would be $253,473 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$225,000
	% and $ Change	12.65%	$28,473
	Adjusted Current Value to Jan 2012		$253,473
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $227,000, a difference of -$26,473.	Current Value Jan 01, 2012		$227,000
	$Difference		-$26,473
Change in Current Value: -10.44%.	%Difference		**-10.44%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		

Project: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			**CV 8**
Property:	1527 Lakeshore Road, Norfolk (Clear Creek)		
	The 6.50 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		606.00	1988.165
Date turbine became operational		Nov 22, 2008	
On January 1, 2008, the average MLS® residential price was $189,279. On January 1, 2012, the average MLS® price was $213,232 resulting in a change of 12.65%.	Average MLS® Price Jan 01, 2008		$189,279
	Average MLS® Price Jan 01, 2012		$213,232
	$Change		$23,953
	%Change		12.65%
The January 1, 2008 Current Value of $231,000 would be $260,233 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$231,000
	% and $ Change	12.65%	$29,233
	Adjusted Current Value to Jan 2012		$260,233
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $211,000, a difference of -$49,233.	Current Value Jan 01, 2012		$211,000
	$Difference		-$49,233
Change in Current Value: -18.92%.	%Difference		**-18.92%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		

Project: Clear Creek, known as Frogmore-Cultus-Clear Creek, about 18 Wind Turbines			CV 9
Property:	1921 Lakeshore Road, Norfolk (Clear Creek)		
	The 24.72 acre site is vacant bush land.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		51.82	170.011
Date turbine became operational		Nov 22, 2008	
On January 1, 2008, the average MLS® residential price was $189,279. On January 1, 2012, the average MLS® price was $213,232 resulting in a change of 12.65%.	Average MLS® Price Jan 01, 2008		$189,279
	Average MLS® Price Jan 01, 2012		$213,232
	$Change		$23,953
	%Change		12.65%
The January 1, 2008 Current Value of $109,000 would be $122,794 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$109,000
	% and $ Change	12.65%	$13,794
	Adjusted Current Value to Jan 2012		$122,794
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $94,000, a difference of -$28,794.	Current Value Jan 01, 2012		$94,000
	$Difference		-$28,794
Change in Current Value: -23.45%.	%Difference		**-23.45%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Simcoe & District MLS® board.		

Project: Raleigh Wind Energy Centre, 52 Turbines			CV 10
Property:	7268 Fourteenth Line, Chatham-Kent (Raleigh)		
	The .91 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		817.28	2681.345
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $158,000 would be $198,971 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$158,000
	% and $ Change	25.93%	$40,971
	Adjusted Current Value to Jan 2012		$198,971
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $169,000, a difference of -$29,971.	Current Value Jan 01, 2012		$169,000
	$Difference		-$29,971
Change in Current Value: -15.06%.	%Difference		**-15.06%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Raleigh Wind Energy Centre, 52 Turbines			**CV 11**
Property:	6510 Thirteenth Line, Chatham-Kent (Raleigh)		
	The 2.11 acre site is improved with a residence with a commercial unit.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		771.45	2530.973
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $136,000 would be $171,267 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$136,000
	% and $ Change	25.93%	$35,267
	Adjusted Current Value to Jan 2012		$171,267
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $154,000, a difference of -$17,267.	Current Value Jan 01, 2012		$154,000
	$Difference		-$17,267
Change in Current Value: -10.08%.	%Difference		**-10.08%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Kruger Energy, Chatham Wind Project Merlin, 44 Wind Turbines			**CV 12**
Property:	21345 Port Road, Chatham-Kent (Merlin)		
	The 1.03 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		776.00	2545.901
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $137,000 would be $172,526 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$137,000
	% and $ Change	25.93%	$35,526
	Adjusted Current Value to Jan 2012		$172,526
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $140,000, a difference of -$32,526.	Current Value Jan 01, 2012		$140,000
	$Difference		-$32,526
Change in Current Value: -18.85%.	%Difference		**-18.85%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Kruger Energy, Chatham Wind Project Merlin, 44 Wind Turbines			CV 13
Property:	3220 Concession 5 Line, Chatham-Kent (Merlin)		
	The 1.50 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		1150.00	3772.920
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $230,000 would be $289,642 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$230,000
	% and $ Change	25.93%	$59,642
	Adjusted Current Value to Jan 2012		$289,642
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $245,000, a difference of -$44,642.	Current Value Jan 01, 2012		$245,000
	$Difference		-$44,642
Change in Current Value: -15.41%.	%Difference		**-15.41%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Kruger Energy, Chatham Wind Project Merlin, 44 Wind Turbines			CV 14
Property:	4564 Badder Line, Chatham-Kent (Merlin)		
	The .62 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		1276.00	4186.301
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $142,000 would be $178,822 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$142,000
	% and $ Change	25.93%	$36,822
	Adjusted Current Value to Jan 2012		$178,822
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $129,000, a difference of -$49,822.	Current Value Jan 01, 2012		$129,000
	$Difference		-$49,822
Change in Current Value: -27.86%.	%Difference		**-27.86%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Kruger Energy, Chatham Wind Project Merlin, 44 Wind Turbines			CV 15
Property:	22064 Port Road, Chatham-Kent (Merlin)		
	The .34 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		1130.00	3707.304
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $100,000 would be $125,931 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$100,000
	% and $ Change	25.93%	$25,931
	Adjusted Current Value to Jan 2012		$125,931
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $90,000, a difference of -$35,931.	Current Value Jan 01, 2012		$90,000
	$Difference		-$35,931
Change in Current Value: -28.53%.	%Difference		**-28.53%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Kruger Energy, Chatham Wind Project Merlin, 44 Wind Turbines			CV 16
Property:	4318 Middle Line, Chatham-Kent (Merlin)		
	The 1.20 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		1620.00	5314.896
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $156,000 would be $196,453 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$156,000
	% and $ Change	25.93%	$40,453
	Adjusted Current Value to Jan 2012		$196,453
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $156,000, a difference of -$40,453.	Current Value Jan 01, 2012		$156,000
	$Difference		-$40,453
Change in Current Value: -20.59%.	%Difference		**-20.59%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Kruger Energy, Chatham Wind Project Merlin, 44 Wind Turbines			**CV 17**
Property:	4422 Middle Line, Chatham-Kent (Merlin)		
	The 1.16 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		1470.00	4822.776
Date turbine became operational		Jan 29, 2011	
On January 1, 2008, the average MLS® residential price was $124,132. On January 1, 2012, the average MLS® price was $156,321 resulting in a change of 25.93%.	Average MLS® Price Jan 01, 2008		$124,132
	Average MLS® Price Jan 01, 2012		$156,321
	$Change		$32,189
	%Change		25.93%
The January 1, 2008 Current Value of $219,000 would be $275,789 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$219,000
	% and $ Change	25.93%	$56,789
	Adjusted Current Value to Jan 2012		$275,789
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $235,000, a difference of -$40,789.	Current Value Jan 01, 2012		$235,000
	$Difference		-$40,789
Change in Current Value: -14.79%.	%Difference		**-14.79%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Chatham Kent MLS® board.		

Project: Enbridge Ontario Wind Farm, 110 Wind Turbines			**CV 18**
Property:	1129 Concession 10, Kincardine (Enbridge)		
	The 1.10 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		894.00	2933.035
Date turbine became operational		Feb 19, 2009	
On January 1, 2008, the average MLS® residential price was $214,038. On January 1, 2012, the average MLS® price was $225,919 resulting in a change of 5.55%.	Average MLS® Price Jan 01, 2008		$214,038
	Average MLS® Price Jan 01, 2012		$225,919
	$Change		$11,881
	%Change		5.55%
The January 1, 2008 Current Value of $332,000 would be $350,429 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$332,000
	% and $ Change	5.55%	$18,429
	Adjusted Current Value to Jan 2012		$350,429
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $346,000, a difference of -$4,429.	Current Value Jan 01, 2012		$346,000
	$Difference		-$4,429
Change in Current Value: -1.26%.	%Difference		**-1.26%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Grey-Bruce MLS® board.		

Project: Enbridge Ontario Wind Farm, 110 Wind Turbines			**CV 19**
Property:	1714 Concession 6, Kincardine (Enbridge)		
	The .58 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		526.00	1725.701
Date turbine became operational		Feb 19, 2009	
On January 1, 2008, the average MLS® residential price was $214,038. On January 1, 2012, the average MLS® price was $225,919 resulting in a change of 5.55%.	Average MLS® Price Jan 01, 2008		$214,038
	Average MLS® Price Jan 01, 2012		$225,919
	$Change		$11,881
	%Change		5.55%
The January 1, 2008 Current Value of $102,000 would be $107,662 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$102,000
	% and $ Change	5.55%	$5,662
	Adjusted Current Value to Jan 2012		$107,662
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $106,000, a difference of -$1,662.	Current Value Jan 01, 2012		$106,000
	$Difference		-$1,662
Change in Current Value: -1.54%.	%Difference		**-1.54%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Grey-Bruce MLS® board.		

Project: Enbridge Ontario Wind Farm, 110 Wind Turbines			**CV 20**
Property:	1314 Concession 10, Kincardine (Enbridge)		
	The 2.98 acre site is improved with a single detached dwelling.		
Turbine Distance to Dwelling (estimated by aerial map scaling)		Metres	Feet
		674.00	2211.259
Date turbine became operational		Feb 19, 2009	
On January 1, 2008, the average MLS® residential price was $214,038. On January 1, 2012, the average MLS® price was $225,919 resulting in a change of 5.55%.	Average MLS® Price Jan 01, 2008		$214,038
	Average MLS® Price Jan 01, 2012		$225,919
	$Change		$11,881
	%Change		5.55%
The January 1, 2008 Current Value of $285,000 would be $300,820 when adjusted for the MLS® passage of time to January 1, 2012.	Current Value Jan 01, 2008		$285,000
	% and $ Change	5.55%	$15,820
	Adjusted Current Value to Jan 2012		$300,820
The Actual Current Value by Municipal Property Assessment Corporation on January 1, 2012 was $257,000, a difference of -$43,820.	Current Value Jan 01, 2012		$257,000
	$Difference		-$43,820
Change in Current Value: -14.57%.	%Difference		**-14.57%**
Passage of time source:	The average residential price source is the Canadian Real Estate Association as provided by the Grey-Bruce MLS® board.		

Conclusion: Municipal Property Assessment Corporation 2008 Current Value vs. 2012 Current Value		
CV 1	375557 6th Line, Amaranth	-0.67%
CV 2	504059 Highway 89, Melancthon	-2.52%
CV 3	582340 County Road 17, Melancthon	-7.53%
CV 4	1480 Lakeshore Road, Norfolk (Clear Creek)	-35.64%
CV 5	71 Norfolk County Road 23, Norfolk (Clear Creek)	-14.81%
CV 6	43 Old Mill Road, Norfolk (Clear Creek)	-28.64%
CV 7	1575 Lakeshore Road, Norfolk (Clear Creek)	-10.44%
CV 8	1527 Lakeshore Road, Norfolk (Clear Creek)	-18.92%
CV 9	1921 Lakeshore Road, Norfolk (Clear Creek)	-23.45%
CV 10	7268 Fourteenth Line, Chatham-Kent (Raleigh)	-15.06%
CV 11	6510 Thirteenth Line, Chatham-Kent (Raleigh)	-10.08%
CV 12	21345 Port Road, Chatham-Kent (Merlin)	-18.85%
CV 13	3220 Concession 5 Line, Chatham-Kent (Merlin)	-15.41%
CV 14	4564 Badder Line, Chatham-Kent (Merlin)	-27.86%
CV 15	22064 Port Road, Chatham-Kent (Merlin)	-28.53%
CV 16	4318 Middle Line, Chatham-Kent (Merlin)	-20.59%
CV 17	4422 Middle Line, Chatham-Kent (Merlin)	-14.79%
CV 18	1129 Concession 10, Kincardine (Enbridge)	-1.26%
CV 19	1714 Concession 6, Kincardine (Enbridge)	-1.54%
CV 20	1314 Concession 10, Kincardine (Enbridge)	-14.57%
Median Decrease		**-14.94%**
Average Decrease		**-15.56%**
Low		**-0.67%**
High		**-35.64%**

A change of minus -0.67% to a high of -35.64% occurred when property values in Ontario were on the increase, $302,191 Jan-08 vs $353,989 Jan-12, average residential prices.

The most recent current valuations were carried out in the 2010-11 period leading up to January 1, 2012. There was virtually NO evidence of value diminution available to MPAC, hence they could not make an adjustment for the influence of a Wind Turbine. Wind Turbines are a NEW phenomenon in Ontario. The first turbines were constructed circa 2005-2008 in Melancthon. However, with the passage of time, and with appeals to the Assessment Review Board, and as sale-resale evidence is documented, MPAC will read the market place and make adjustments resulting from the influence of Wind Turbines.

July 10, 2012, For immediate release

OTTAWA - Health Canada, in collaboration with Statistics Canada, will conduct a research study that will explore the relationship between wind turbine noise and health effects reported by, and objectively measured in, people living near wind power developments.

"This study is in response to questions from residents living near wind farms about possible health effects of low frequency noise generated by wind turbines," said the Honourable Leona Aglukkaq, Minister of Health. "As always, our Government is putting the health and safety of Canadians first and this study will do just that by painting a more complete picture of the potential health impacts of wind turbine noise."

Health Canada is aware of health-related complaints from individuals living in close proximity to wind turbine establishments. The study is being designed with support from external experts, specializing in areas including noise, health assessment, clinical medicine and epidemiology.

The proposed research design and methodology was posted on Health Canada's web site today for a 30-day public comment period. Feedback obtained will be reviewed by the design committee, compiled and published to the website, along with the design committee's responses.

The study will be focused on an initially targeted sample size of 2,000 dwellings selected from 8-12 wind turbine installation facilities in Canada. In addition to taking physical measurements from participants, such as blood pressure, investigators will conduct face-to-face interviews and take noise measurements inside and outside of some homes to validate sound modelling.

Health Canada has expertise in measuring noise and assessing the health impacts of noise because of its role in administering the Radiation Emitting Devices Act (REDA). As defined under REDA, noise is a form of radiation.

The study results are expected to be published in 2014.

Contact: David S. Michaud, PhD, Principal Investigator, Health Canada
Consumer and Clinical Radiation Protection Bureau
Healthy Environments and Consumer Safety Branch
Email: wind.turbine.health.study@hc-sc.gc.ca

Guelph, ON [January 20, 2012] – Escalating concerns about industrial wind turbines have prompted the Ontario Federation of Agriculture (OFA) to urge the province of Ontario to suspend further development until farm families and rural residents are assured that their interests are adequately protected. The OFA unveiled its strong stance in a new position statement on industrial wind turbines, released today, that will be presented to government later this month.

Since 2007, when the development of industrial wind turbines began in Ontario, the OFA has worked with government on regulations, cautioned farmer members on the pitfalls of wind leases and expressed concerns about pricing. Many of these issues have not been addressed, causing tremendous tension among rural residents and community neighbours.

“We are hearing very clearly from our members that the wind turbine situation is coming to a head – seriously dividing rural communities and even jeopardizing farm succession planning,” says OFA President Mark Wales. “The onus is on our provincial government to ensure the interests of rural Ontarians are protected. OFA is speaking up to clearly outline the issues that must be addressed right now.”

The OFA’s new position statement on industrial wind turbine development addresses a number of concerns of rural Ontarians, including:

- Price paid for wind power
- Inefficiency of wind power – it can’t be stored for use during peak demand periods
- Setback issues and induced currents
- Health and nuisance issues
- Removal of municipal input from industrial wind turbine projects

OFA has always supported Ontario’s need for a reliable, affordable source of renewable energy for our future. “We must all work together to ensure green energy projects respect concerns for noise, community involvement and price, balanced with the effective provision of energy,” says Wales.

Read the full OFA position statement on industrial wind turbines here.

The Ontario Federation of Agriculture (OFA) is the largest general farm organization in Ontario, representing 37,000 farm families across the province. As a dynamic farmer-led organization based in Guelph, the OFA works to represent and champion the interests of Ontario farmers through government relations, farm policy recommendations, lobby efforts, community representation, media relations and more. OFA is the leading advocate for Ontario’s farmers and is Ontario’s voice of the farmer.

Mark Wales, President, Ontario Federation of Agriculture

Jan 25, 2012

CanWEA disappointed with OFA statement on wind, will continue to work to ensure farmers enjoy productive relationship with wind energy

The Canadian Wind Energy Association (CanWEA) is extremely disappointed that the Ontario Federation of Agriculture (OFA) has called for a suspension of wind energy development at a time when farmers across the province are actively participating in, and seeking to participate in, wind energy developments throughout Ontario. In fact, many of the issues that the OFA has identified as areas of concern are already being reviewed and examined through processes like the Ontario Government's Feed-in-Tariff (FIT) Review process.

"We are surprised and disappointed the OFA is proposing to put thousands of jobs at risk in Ontario and limit the ability of farmers to participate in Ontario's clean energy economy," said Robert Hornung, CanWEA president. "We will be seeking a meeting with the OFA to better understand their point of view and discuss their concerns and will remain active participants in the processes that are already in place to discuss many of these issues."

The wind energy industry has a long history of working with the agricultural community and in fact sees farmers as a key partner in wind energy development as thousands of Ontario farmers are participating in Ontario's clean energy economy through FIT and microFIT programs. CanWEA has worked with leaders within the OFA and other agricultural associations to inform our best practices in stakeholder engagement and to ensure the industry continues to be a good partner.

"We will continue to provide fact-based answers to ensure Ontarians have the information they need to make informed choices as Ontario moves towards a cleaner, stronger and affordable energy system," added Robert Hornung.

For more information on wind energy visit: http://www.canwea.ca/wind-energy/talkingaboutwind_e.php

For information, please contact:
Ulrike Kucera, Media Relations, Canadian Wind Energy Association
613 234 8716 ext. 228
Mobile 613 867 4433

Ontario wind power bringing down property values — CBC News

OCT 3 Posted by ccsage

CBC News has published a major investigative report on losses in market values of Ontario residential properties located near wind turbines. It reports actual and anticipated losses of 10-50%, increased time to sell and potential difficulties in obtaining a mortgage. There is also a poll showing the percentage of people willing to live near wind turbines.

Some excerpts from the report:

… The CBC has documented scores of families who've discovered their property values are not only going downward, but also some who are unable to sell and have even abandoned their homes because of concerns nearby turbines are affecting their health."

… The president of the Brampton Real Estate Board [Chris Luxemburger] examined real estate listings and sales figures for the Melancthon-Amaranth area, home to 133 turbines in what is Ontario's first and largest industrial wind farm. "Homes inside the windmill zones were selling for less and taking longer to sell than the homes outside the windmill zones," said Luxemburger. On average, from 2007 to 2010, he says properties adjacent to turbines sold for between 20 and 40 per cent less than comparable properties that were out of sight from the windmills.

… Canadian Hydro Developers bought out four different owners [who threatened legal action] for $500,000, $350,000, $305,000 and $302,670. The company then resold each property, respectively, for $288,400, $175,000 (50% loss), $278,000 and $215,000. In total, Canadian Hydro absorbed just over half a million dollars in losses [34%] on those four properties.

… last February, before an environmental review tribunal in Chatham, Environment Ministry lawyer Frederika Rotter said: …"That's what makes them sick is that, you know, they'll get less money for their properties, and that's what's causing all this annoyance and frustration and all of that."

… Getting a mortgage on her house might not be that easy. CBC News has learned that already one bank in the Melancthon area is not allowing lines of credit to be secured by houses situated near wind turbines. In a letter to one family situated close to the turbines, the bank wrote, "we find your property a high risk and its future marketability may be jeopardized."

Reinforcing the information contained in the above report, a CBC News poll indicates that only 23% of more than 1700 responders would be willing to live near wind turbines, thereby reducing the number of potential buyers by three-quarters.

Source: http://ccsage.wordpress.com/2011/10/03/ontario-wind-power-bringing-down-property-values-cbc-news/

TransAlta™

Melancthon

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The Melancthon wind facility is Ontario's first utility-scale wind facility. It is one of the largest wind projects in Canada, with 133 wind turbines producing 200 megawatts of power. The facility is located near Shelburne, Ontario.

Phase I of the project began commercial operation in 2006, with Phase II beginning commercial operation in late 2008.

The Melancthon facility has the capacity to generate 545,000 megawatt hours each year.

The 20-year Renewable Energy Supply contract with the Ontario government creates long-term pricing stability.

TransAlta owns and operates the Melancthon facility through its wholly owned subsidiary Canadian Hydro Developers.

Note: We gratefully acknowledge Natural Resources Canada (NRCan) for its support for phase II of this project through the eco Energy for Renewable Power (eERP) program. Phase I is supported by the Wind Power Production Incentive Plan.

At a Glance

- **Technology:** GE 1.5 MW turbines, 80 metre towers

Environmental Highlights

- The Melancthon facility is EcoLogo[M] certified by the Environmental Choice Program.
- **Transformer station accoustic audits** - Click here.

Facts & Figures

- Location: Shelburne, ON
- Fuel: Wind
- Capacity (MW): 200
- Ownership: 100%
- Operator: Yes
- First on-stream: 2006
- Revenue Source: LTC
- Builder: Yes
- Contract Expiry: 2026-28

Related Documents

NEW - Melancthon Newsletter, October 2010

Related Pages

- Ontario community page
- Transformer station acoustic audits

Source: http://www.transalta.com/

"At the end of 2010, TransAlta became the first company to own and operate more than 1,000MW of installed wind capacity in Canada – almost 30 per cent of the country's total."

August 11, 2008

AIM PowerGen commissions Frogmore and Cultus wind farms

TORONTO

AIM PowerGen Corp. has announced the commissioning of the Frogmore and Cultus wind farms.

The projects, developed under Ontario's Renewable Energy Standard Offer Program, each have a total installed capacity of 9.9 megawatts (MW) and will produce enough power to supply 3,000 average households for one year.

Mike Crawley, CEO of AIM PowerGen, says these projects are among the first to be built under Ontario's Standard Offer Program.

"We are pleased that Frogmore and Cultus wind farms are now on-line and providing clean, renewable energy to the province," says Crawley. "The Standard Offer program was a ground-breaking initiative for the province and has allowed smaller projects such as these to be competitive and developed to support Ontario's evolving energy system."

The wind farms, located in Norfolk County on the northern shore of Lake Erie, are each comprised of six Vestas V82 1.65 MW turbines. Six landowners are hosting the 12 turbines on their properties.

"Many of these turbines are hosted by landowners that we approached over six years ago. These people embraced Ontario's energy revolution very early on and acted as pioneers in making this a reality", says Jim Wilgar, project manager and site consultant on the projects.

These are the first of four projects that AIM expects to commission in Ontario this summer. The Clear Creek Wind Farm, also in Norfolk County and the Mohawk Point Wind Farm, in Haldimand County, are expected to come on-line later this year. Construction on these wind farms is complete and AIM is finalizing interconnection issues with the local distribution company prior to commercial operation.

http://dcnonl.com/article/id29812

Sound, Noise:

"Applicants and regulators should have foreseen the very negative noise response from neighbors living near wind turbine sites. By their not adequately understanding the sound character generated by wind turbines, appropriate corrections to prevent annoyance were not included in the noise predictions. Wind turbine noise has a unique and visceral sound character, which may be perceived as being twice as loud as measured."

Source: Stephen Ambrose and Robert Rand, Rand Acoustics

An uncompensated taking:

"A wind "farm" creates an easement in gross over neighboring, non-participating property that impairs value. Thus, it is tantamount to an "inverse condemnation", or regulatory taking of private property rights.....an uncompensated taking."

Source: Sept. 22, 2012 by Michael S. McCann, CRA, McCann Appraisal, LLC (Chicago, Illinois, USA).

Ben Lansink's Canadian interpretation of Mr. McCann's statement:

A wind "farm" creates an easement in gross over neighboring, non-participating property that impairs value. Thus, it is tantamount to an "inverse expropriation", or regulatory taking of private property rights, but is effectively an uncompensated taking.

Reliability, Hierarchy of Evidentiary Value:

1. **Case Study Data**: The most reliable method for determining property value

   The most reliable evidence is represented by Case Studies, or individual examples of value loss, directly linked to the cause of value loss.

2. **Paired Sales**: The second most reliable method for determining property value

   With that said, the second most reliable basis for demonstrating a "detrimental conditions" valuation opinion, when one does not have enough factual background on Case Studies, is the use of "paired sales." That is, one sale near turbines and one far away, in order to isolate the impact of the turbines on value.

3. **Regression Analysis**: The least reliable method for determining property value. (This method has been used by the wind industry.)

   Regression Analysis is the technique that was used by the now well-circulated Hoen/Lawrence Berkeley National Laboratory report. The Appraisal Institute (US) recognizes this technique as the third and least reliable method, which should only be used in the absence of data, such as the type of Case Study data that is most reliable and preferable, or absent the data to perform a Paired Sales analysis.

Source: Michael S. McCann, CRA, McCann Appraisal, LLC (Chicago, Illinois, USA).

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RIDGETOWN, Ont. N0P 2C0
Ph. 519-674-0221

335 St. Main St.,
BOTHWELL, Ont. N0P 1C0
Ph. 519-695-5718

April 24, 2012

Dear

On speaking with the Western General Insurance Company in regard to your inquiry about the installation of wind turbines on your property at Sarnia, Ontario, the Company has advised that should a wind turbine be erected on the property, the Western General would not insure same and they would no longer remain on risk at that property, and your policy would therefore be cancelled.

The Company has also stated that once the units are erected, you, the owner of the property lose some control on people coming onto the property for repairs or maintenance, along with some injury risk the units could cause, leaving yourself and the Company open to potential liability losses.

Yours very truly

Laurie E. MacLean

LM

Laurie E. Maclean, A.I.I.C., C.I.P.
Principal/Partner
Gary K. STEWART INSURANCE BROKERS
Limited

RBC Royal Bank

Royal Bank of Canada
136 Broadway
Orangeville, Ontario L9W 1J9
Tel.: 519-941-2610
Fax.: 519-941-2095
1-800-769-2511

August 18, 2011

Mr. Paul D. Thompson
214242 Tenth Line
Grand Valley, On
L0N 1G0

Dear Paul:

It is with regret that I must advise that we are unable to put a secured credit line on your property. The property was appraised and based on the report and the health concerns mentioned therein, the report is hypothetical in nature and the health risks caused by the hydro station located close to your home, we find your property a high risk and its future marketability may be jeopardized.

Please rest assured that you are a high value client with RBC and your credit with us has never been an issue, however, the property at this time has caused some concerns.

Please feel free to contact me at 519 -943 -0012 if you require further clarification.

Regards,

Belinda S. Reid

Ms. Belinda S. Reid
RBC Mortgage Specialist

Aaron: ARB ruling on wind power noise sets precedent

January 9, 2010 Bob Aaron, Toronto Star

In a precedent setting move, a recently discovered decision of the provincial Assessment Review Board (ARB) has cut a homeowner's assessment in half because the house is located near a noisy hydro substation. The hydro plant serves a nearby wind farm producing "clean" electricity.

The decision of ARB member Ana Cristina Marques was issued following an appeal by Paul Thompson of the assessment on his house.

Thompson's one-storey home is located on the 10th Line in Amaranth Township. It was built in 1989 and sits on a lot with a frontage of 183 feet (55.7 meters) and a depth of 240 feet (73.15 meters).

In 2008, the Municipal Property Assessment Corp. assessed the 1,320-square-foot house at $255,000. Thompson agreed with the assessment except for one thing: The house sits across the road from a Canadian Hydro Developers transformer station. The station converts the output of the nearby Melancthon I wind plant into electricity for the Ontario power grid.

Thompson told me last month that the station emits a "wicked buzz" all day, every day, and that's what prompted him to appeal his assessment.

Evidence presented to the board at Thompson's appeal revealed that in April 2005, the township of Amaranth rezoned a 6.07 hectare (15-acre) parcel across the road from Thompson's home for the purpose of construction of a transformer station.

The station was built 360 meters (1,181 feet) away from Thompson's house. According to the Ontario Power Authority website, it serves the Melancthon I Wind Plant, a 67.5 MW facility in the southern portion of the Melancthon Township, Dufferin County, near the Town of Shelburne.

The first phase of the project utilizes 45 wind turbines. It became operational in March 2006, and the second and much larger phase (88 turbines) began producing electricity in March 2008.

The Ontario Power Authority website says that "manufacturers of modern wind turbines have … reduced noise levels to that of a quiet whisper."

That may be so, but evidence at the ARB hearing showed that the power station associated with Melancthon I produced a constant hum measured at more than 40 decibels in Thompson's home. (According to a 1999 World Health Organization report, sleep disturbance occurs when there is a continuous noise exceeding its indoor guideline value of 30 decibels.)

Thompson introduced evidence at the hearing showing that the transformer station noise was audible within the house with the windows closed. He described the noise as a "nightmare" and a constant nuisance that not only affects his day-to-day activity, but also impacts the sales value and marketability of his property.

In reaching its decision to cut his assessment in half, board member Marques wrote,

“The Board finds that the constant hum alleged by Mr. Thompson does exist and significantly reduces the current value of the subject property. The best evidence is the audio portion of the CD (Exhibit No. 1) and the testimony of both parties.

“Having heard this nuisance, apparently sanctioned by the Municipality, the Board accepts Mr. Thompson’s testimony that the stigma of noise contamination has a negative impact on the value and marketability of the property, and that after learning of the hum, prospective purchasers will quickly lose interest in purchasing the property. The Board is satisfied that a very substantial reduction is warranted.”

As I see it, Thompson’s successful appeal of his assessment is only the first of many similar cases that are certain to follow. The result, of course, will be a significant reduction in the tax base of municipalities like Amaranth, which play host to wind turbine farms.

And now that the ARB, an arm of the Ontario government, has upheld a claim for loss of property value due to the proximity of a hydro substation and a wind farm, can a host of court cases and class action lawsuits for noise contamination and property devaluation be far behind?

Bob Aaron is a Toronto real estate lawyer and board member of the Tarion Warranty Corp. bob@aaron.ca.

Source: http://www.yourhome.ca/homes/columnsblogs/article/747191--aaron-arb-ruling-on-wind-power-noise-sets-precedent

The Ontario Real Estate Association (OREA) has a Seller Property Information Statement on which the seller discloses to the buyer any "latent or patent defects" about the property the seller is selling.

OREA Ontario Real Estate Association

Seller Property Information Statement
Residential

Form 220
for use in the Province of Ontario

ANSWERS MUST BE COMPLETE AND ACCURATE This statement is designed in part to protect Sellers by establishing that correct information concerning the property is being provided to buyers. All of the information contained herein is provided by the Sellers to the brokerage/broker/salesperson. Any person who is in receipt of and utilizes this Statement acknowledges and agrees that **the information is being provided for information purposes only and is not a warranty as to the matters recited hereinafter even if attached to an Agreement of Purchase and Sale**.The brokerage/broker/salesperson shall not be held responsible for the accuracy of any information contained herein.

BUYERS MUST STILL MAKE THEIR OWN ENQUIRIES Buyers must still make their own enquiries notwithstanding the information contained on this statement. Each question and answer must be considered and where necessary, keeping in mind that the Sellers' knowledge of the property may be inaccurate or incomplete, additional information can be requested from the Sellers or from an independent source such as the municipality. Buyers can hire an independent inspector to examine the property to determine whether defects exist and to provide an estimate of the cost of repairing problems that have been identified.
This statement does not provide information on psychological stigmas that may be associated with a property.

The following is the exact wording on the standard form.

Environmental:

1. Are you aware of any environment problems of any kind on the property or in the immediate area? eg: radon gas, toxic waste, underground gasoline or fuel tanks etc.

2. Are there any existing or proposed waste dumps, disposal sites or landfills in the immediate area?

3. Are there any hydro generating projects planned for the immediate area? eg: Wind Turbines?

BIRDS and BATS

Billions of birds migrate annually, taking advantage of the same wind currents that are most beneficial for producing wind energy. As many as 440,000 birds are killed by existing wind turbines in the US every year.

Wind Power: Good Things in Good Places

Nature Canada supports the development of wind energy in Canada, coupled with conservation measures to reduce all forms of fossil fuel consumption.

But wind energy must not be produced at the expense of wildlife.

Wind turbines and wind farms should not be located in places – such as Important Bird Areas – where birds congregate, migrate and breed.

All wind farm proposals should be subject to an environmental assessment prior to development in order to evaluate their impact on all wildlife, including birds and bats.

Regulators such as the provincial and territorial governments should adopt policies and guidelines that exclude wind energy projects from Important Bird Areas and other areas that are known to be of importance to birds and bats.

Any wind farms that already exist within migratory corridors or bottlenecks should be subject to the best practices for mitigating their impacts on birds, especially during migration season.

Source: http://www.naturecanada.ca/advocate/wind.html?gclid=CNOt9u6027ICFexAMgodIIgAVQ

Bats, despite their ability to use sonar to avoid moving objects, are susceptible to '"barotrauma", a sense of disorientation caused by the rapid change of air pressure created by a turbines rotating blade.

“Dead bats are turning up beneath wind turbines all over the world. Bat fatalities have now been documented at nearly every wind facility in North America where adequate surveys for bats have been conducted, and several of these sites are estimated to cause the deaths of thousands of bats per year. This unanticipated and unprecedented problem for bats has moved to the forefront of conservation and management efforts directed toward this poorly understood group of mammals. The mystery of why bats die at turbine sites remains unsolved. Is it a simple case of flying in the wrong place at the wrong time? Are bats attracted to the spinning turbine blades? Why are so many bats colliding with turbines compared to their infrequent crashes with other tall, human-made structures?”

Source: http://www.mesc.usgs.gov/BatsWindmills/

PERCEPTION

Perception motivates a buyer to make a buying decision. Examples are perceived enjoyment of a dwelling home, perceived income stream from a property, etc. Perception is the result of knowledge obtained via literature, print media, electronic media, and the internet. For example, burning turbines paint the perception the turbines can be dangerous.

Wind Turbines Can Cause Liability Issues

Can this happen to a Wind Turbine?

Source for the Photos: the www

Perception need not be based on a proven or a scientific fact.

Certification by Ben Lansink – CASE STUDY

I, Ben Lansink, certify to the best of my knowledge and belief that:

This document is not an appraisal report, a technical review, or a consulting report, as defined by the Appraisal Institute of Canada. It is a Case Study, an analysis of facts pertaining to the wind turbine phenomenon.

The statements of fact contained in this case study are true and correct.

The reported analyses, opinions, and conclusions are my personal impartial and unbiased professional analyses, opinions, and conclusions. No one provided professional analysis assistance to me.

I have no bias and no present or prospective personal interest with respect to the Melancthon and the Clear Creek Wind Turbine Facilities, issues that are the subject matter of this Case Study, or to the public who may receive this Case Study.

The writing of this Case Study was not contingent upon developing or reporting predetermined results, the amount of the diminution estimate, or a conclusion favouring anyone.

My analyses, opinions, and conclusions were developed, and this Case Study has been prepared, in conformity with (1) the Canadian Uniform Standards of Professional Appraisal Practice (CUSPAP), Appraisal Institute of Canada; (2) the Uniform Standards of Professional Appraisal Practice (USPAP), Appraisal Standards Board, United States; and (3) the International Valuation Standards (IVS).

I have the knowledge and experience to complete this Case Study competently.

The Appraisal Institute of Canada has a Continuing Professional Development Program. As of September 2012, I have fulfilled the requirements of this Program. I am a member in good standing of the Appraisal Institute of Canada.

Should any evident errors or omissions or additional undisclosed or unavailable facts become known, I reserve the right to revise this Case Study and its findings.

Respectfully submitted,

Ben Lansink, AACI, P.App, MRICS   Date: February 2013
Lansink Appraisals and Consulting
Telephone: 519-645-0750x24   Email: ben@lansink.ca

End of Case Study – Last Page

This is the last page of this Case Study.

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filed: April 4, 2018 • Alberta, Opinions

Wind turbines affect property values

> ***Credit:*** The Battle River Group is concerned about the proximity of turbines in Capital Power's application | By Lisa Joy | Stettler Independent | Apr. 3, 2018 | www.stettlerindependent.com ~~

The Alberta Climate Leadership Plan (ACL), which aims to end coal-fired electricity generation facilities by 2030, has companies like Capital Power scrambling to meet the province's increased power needs.

To meet this increased need, Capital Power applied with the Alberta Utilities Commission (AUC) for Halkirk 2 that would see 74 wind turbine generators, a collector system and a substation erected five miles north of Halkirk. Halkirk 2 would generate 148 megawatts and meet the needs of about 500,000 Alberta homes annually. Halkirk 2 is in addition to the current Halkirk Wind Farm that has 83 turbines.

Meeting the increased power needs in cities, however, is creating land use conflicts in rural areas. The Battle River Group (BRG) is fighting Capital Power's application for Halkirk 2. They want Paintearth County to make the wind turbine setback 1.5 km from homes instead of the proposed 500 metres. The BRG is also concerned about the wind turbines decreasing their property value.

They might be onto something.

Real estate and appraisal businesses maintain that wind power does affect property values. Michael McCann of McCann Appraisal, LLC out of Chicago said that "residential property values are adversely and measurably impacted by close-proximity of industrial-scale wind energy turbine projects to the residential properties," if they are up to 3.2 km away. They decrease a property's value by 35 to 40 per cent.

According to the London School of Economics, wind farms decrease property value by up to 12 per cent if the home is within a two km radius and can even affect a property's value up to 14 km away from the home.

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Latest News
Illinois: Neighbors file lawsuit to stop Henry County wind farm
Kansas: Man takes his wind energy concerns to county
New Mexico, Opinions: Proposed wind turbine project in Eddy County has many dangers
Nebraska: In conflict-of-interest case, judge rules 2 Cherry County Board members can't vote on wind project
Kansas: District judge asked to be recused from wind project suit
Pennsylvania:

In fact, the Ontario Superior Court ruled in 2013 that landowners living near large wind farms suffer from lower property values. That court said it decreased property values by 22 to 55 per cent.

Clearly, wind turbines do affect landowners' property values. Paintearth County proposes a 500-metre setback from homes. The landowners want a 1.5 km setback. Given that studies prove property values decrease when wind turbines are two km from homes, is a 1.5 km setback even enough?

> ***Source:*** The Battle River Group is concerned about the proximity of turbines in Capital Power's application | By Lisa Joy | Stettler Independent | Apr. 3, 2018 | www.stettlerindependent.com
>
>

Some possibly related stories:

- Evidence inconclusive as to whether turbines affect property values
- Study shows wind turbines have mixed affect on property values
- Appraiser: Wind farm won't affect property values
- Wind turbines will hurt property values
- Analysis: Experts divided on how wind farms affect property values
- Turbines impact property values

Windmill hearing continues today
Oklahoma:
Public Service Co. of Oklahoma joins sister utility to propose significant wind development across north-central Oklahoma
West Virginia:
PSC sets public hearing on proposed Black Rock Wind Farm
Australia, Press releases:
Death by a thousand blades
Australia, Opinions:
A proposal to build hundreds of 270m-high wind turbines on Robbins Island should be worrying
Australia:
Crusader Brown turns against wind farm
Ireland:
Farmers 'up in arms' over wind farm development in Cavan
Michigan:
Local group ups media battle against DTE Energy
Letters, South Dakota:
Loopholes for wind farm developers need fixing
Australia:
Bob Brown rebukes Tasmanian windfarm project as the new Franklin dam
Nebraska:
Lawsuit says 2 Cherry County Board members have conflicts of interest in wind farm fight
Ohio:
Strangled Ohio wind industry: 'We don't want to give up'
Scotland:
Skilled workers turn to food banks after wind farm contract sell-off
Nebraska:
Group challenges R-Project route in court
New York:
Developer: We won't pursue wind farm in waters off Hamptons
Indiana:
Residents divided over proposed

Posey Co. wind turbine farm
New York:
Villenova back to work on wind turbine project
Ireland:
Protest planned over energy projects
England:
Fears over impact of planned 300ft wind turbines on children at new Hartlepool school
Maine:
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Properties near wind turbines lose value, says land economist

A new study confirms the loss of property value near industrial-scale or utility-scale wind power projects, but flaws in the methodology don't show just how bad the situation really is

November 28, 2018

University of Guelph associate professor Richard Vyn sent along his recent paper on wind turbines and property values, published in the current issue of *Land Economics*.

The paper, titled "Property Value Impacts of Wind Turbines and the Influence of Attitudes toward Wind Energy," concludes with this paragraph:

> "The results of this study provide **strong evidence that wind turbines in Ontario have negatively impacted surrounding property values**. The results also demonstrate that these impacts increase with the number of turbines in close proximity. Hence, this study adds to the evidence contributed by more recent empirical studies that wind facilities can impact property values."

Mr. Vyn structured his study around the notion of comparing property values between willing communities and "unwilling host" communities as a way of examining the effect of "different attitudes toward wind energy."

His supposition was that the "nature of turbine impacts … may be influenced by attitudes…" In fact, he writes, he investigates whether the "increase in concerns expressed publicly and through the media have contributed to a greater impact on property values."

For property values in the "opposed municipalities," Vyn estimates property value loss is 5.61% to 9.10% during the announcement period for a wind power project, and 7.93% to 9.42% in the post-construction period.

Citizen opposition a factor

The author blames citizen opposition and media attention to negative attitudes. Media attention due to active opposition by "grassroots organizations such as **Wind Concerns Ontario**," he says, so impacts on health and property values have been covered in the media with the result that "This media attention, which has increased substantially in recent years, may have influenced attitudes toward wind energy and perceptions of turbine impacts."

So, which is the chicken and which is the egg? The thousands of official government records of reports of noise emissions from wind turbines, adverse health effects, disturbed or failed water wells, and shadow flicker or strobe effect have *nothing* whatever to do with property value, it may just be down to citizen groups expressing opposition?

The word "noise" is not mentioned in the paper. Neither is the fact that leaseholders must acknowledge the negative impacts of wind turbines and sign a non-disclosure agreement. And, the study area was of "mature" wind power projects in which it must be acknowledged that people experiencing the worst effects have probably already left?

Expired sales omitted

We asked an accredited professional in real estate valuation to review the paper. His findings are summarized here.

> **Willing vs. unwilling**: The bifurcation between willing and unopposed communities is artificial, and supposes that there will be minimal effects on value in willing communities. The fact is, almost every wind power project in Ontario—including those in the unorganized communities in Ontario's North—was opposed to the extent that

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@ScottLuft Well that sounds about right.

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citizens took steps to appeal the projects and in many cases, also proceeded to court.

> **Flawed supporting studies**: Among others, the author cites the Heintzelmann, Vyn and Guth study of properties on Wolfe Island, which was based on MPAC data, but "ignores key information from MLS sources which clearly demonstrate an active market on the east of the island where there are no turbines, and stagnant market conditions typified by expired listings and no sales on the west end among the turbines. Had the researchers looked at the geographic location of the sales data they used in relation to the wind turbines, it would have been immediately clear that the turbines were stifling the market on the west half of the island. Instead, they took it as a data set and did 'hedonic magic' to reach a conclusion that was clearly at odds with reality."
>
> **Treatment of turbine impact**: A "weakness in the study is found in the pooling of sales by wind farm leading to aggregation of impacts. Usually this results in an average and, given that there are fewer sales in close proximity to wind turbines—for obvious reasons—the average [property value loss] would tend to be lower, given the larger number of sales at greater distance from the turbines. The admission of a weak market close to the turbines says a lot … but the obvious conclusion is ignored by the author."
>
> **The story is in the sales**: "It is clear from the study that proximity to wind turbines dampens market activity and lowers property value but there is no support for the blame the victim aspect of their conclusions. As a result of pooling data, it is likely that the magnitude of property value loss is seriously understated."
>
> **No credentials**: Finally, our analyst comments that the author has no credentials in real estate or in the professional practice of valuation. "As a result, the analysis of the real estate market is without weight."

For our part, while we are happy to see research into the negative economic impacts of industrial-scale or utility-scale wind power projects, this study didn't go far enough, or use methodology that would really address the issues.

Once again, the fundamental belief seems to be that there is something wrong with the idea of people objecting to the presence of industrial-scale wind turbines. Again, the word "noise" is not mentioned. The Ontario Real Estate Association Seller Information sheet has a question pertaining to the existence of any plans near a property to be sold for quarries, garbage dumps, or wind turbines. So, the "disamenity" or reason why people would value the property less is noise and construction activity for quarries, and smell and again noise and truck traffic for a garbage dump. But for wind turbines, the author alleges the only possible reason could be how the turbines look and the possible negative influence of information from citizen groups in opposition.

In other words, the author doesn't believe there could be any rationale for an objection to living near 500-foot noisy industrial structures.

Giant pro-wind PR machine

We are sorry to say that this paper appears to be yet another volley in what environment writer Jude Clemente said in *Forbes* magazine said is "a heavily funded public relations machine to make Americans think that wind power doesn't impact property values, and it's every bit as influential as the 'Big Oil' the anti-fossil fuel movement purports to be so against."

"Many members of the Real Estate and Appraisal businesses, however, have been clear that wind power DOES impact property values," Clemente concludes. "It would seem to me that these groups have no vested interest in supporting wind power or not supporting it…. Wind's impact on local property values can no longer be ignored."

So, while Mr Vyn acknowledges property value loss and impact on Ontario communities from being forced to "host" wind power projects, he does so in such a way as to diminish the effect, while apparently dismissing the valid concerns of residents for the impacts on health, the environment, and the economy.

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Is this extortion? Why are people whose homes are surrounded by turbines still being forced to pay unadjusted tax rates?
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People were definitely forced against their will to have their homes surrounded by turbines. They did not consent to being harmed in any way.
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Look at the most recent presentation given by Dr. Mariana Alves-Pereira in Slovenia in May 2018. She has publicly stated that knowing what she knows about the neurological damage which can lead to adult onset seizures as well as the cardiovascular damage that is cumulative and irreversible and could be fatal, she would not live within 20 km of a wind turbine and yet here in Ontario, we have peoples' homes surrounded by turbines! These turbines need to be turned off and dismantled.
Anyone who does not get this is choosing to be wilfully blind and in effect complicit to this unethical, unjust, cruel reality.

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JANUARY 8, 2019

Building wind turbines where they're not wanted brings down property values

by Richard Vyn, The Conversation

Areas with greater opposition to wind energy development may be more likely to experience negative impacts on property values. Credit: Shutterstock

The question of whether or not wind turbines have decreased property values in Ontario has been a point of contention in recent years, and fuelled by the rapid expansion of the wind energy industry following the implementation of the Green Energy Act in 2009. (The current provincial government is in the process of repealing the act.)

Residents in communities with existing and proposed wind farms have felt their concerns have been largely ignored by the provincial government, which is able to override municipal decisions regarding where wind farms can be located. Wind farm development was allowed to proceed despite not reaching resolution on this issue. This is due in part to a lack of scientific evidence regarding these impacts.

Studies in other jurisdictions around the world have not provided a clear answer as to whether property values drop when a wind farm is built nearby. Negative impacts on property values have occurred in some jurisdictions including in the Netherlands, but not in others.

To determine whether property values have changed as a result of wind turbines in Ontario, I conducted a study using sales of rural residential properties. In particular, the study focused on counties in southern Ontario where wind farms have been constructed.

Unwilling hosts

This study also addresses underlying reasons for the lack of consensus across related studies in other jurisdictions. There are a number of potential contributing factors, including the possibility that differences in attitudes toward wind energy may influence the likelihood of property value impacts. Areas with greater opposition to wind energy development may be more likely to experience negative impacts on property values. I examined the degree to which differences in attitudes influenced property values in Ontario.

Ontario provides an ideal setting to examine whether differences in attitudes influence property value impacts. To date, 95 municipalities have passed resolutions to declare themselves "unwilling hosts" for wind farms. They did this to protest the provincial government's ability to override municipal decisions on the location of wind energy facilities.

While these declarations are only symbolic, they show that most residents oppose wind energy, since these declarations tend to be made in response to requests for public input and feedback from residents.

In contrast, other municipalities within the province have supported wind energy development. As such, the unwilling host designation can be used to identify differences in attitudes toward wind energy across municipalities.

Property values in unopposed municipalities

The first component of the study determined whether wind turbines have affected property values in Ontario. I analyzed sales data from more than 22,000 rural residential properties across 14 counties in southern Ontario between 2002 and 2013. Many of these properties are in close proximity to wind turbines.

Wind turbines caused negative impacts on property values up to four kilometres away, with these impacts ranging from a four per cent to an eight per cent decrease in property values. The magnitude of the impact increased as the number of wind turbines in close proximity to the property increased. These results support the concerns of residents of communities with existing and proposed wind farms regarding the potential loss in value of their properties due to wind turbines.

To determine whether differences in attitudes influenced the observed impacts of wind turbines on property values, I divided the sales data into two groups: those in unwilling-host municipalities and those in municipalities that had not made such declarations, which I refer to as "unopposed municipalities."

Impact findings on property values

The analysis of the sales data for each group yielded interesting results. Wind turbines had a negative impact on property values only in unwilling host municipalities, while no impacts were observed in unopposed municipalities. These results suggest that residents' attitudes toward wind energy may influence the nature of turbine impacts: jurisdictions with greater opposition to wind turbines may be more likely to experience negative impacts on property values.

Prior to my study, there had not been a comprehensive study conducted in the province on the impacts of wind turbines on property values. The results may help to explain the lack of consensus that exists across prior studies regarding this issue. It could be the case that the concerns expressed regarding potential negative impacts draw considerable local attention to this issue. This, in turn, could influence perceptions of turbine impacts and the resulting demand for affected properties.

Provided by The Conversation

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LOCAL IMPACTS OF WIND FARMS ON PROPERTY VALUES: A SPATIAL DIFFERENCE-IN-DIFFERENCES ANALYSIS

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ABSTRACT

Today's investment decisions in large-scale onshore wind projects in Germany are no longer determined only by the investment's economic benefit, but also by concerns associated to social acceptance. Despite a mostly positive attitude towards the expansion of wind power, local public concerns often stem from the belief that the proximity to large-scale wind farms may lead to a decrease in property prices. In particular, the change in landscape caused by the construction of a wind farm may have an impact on the view from some properties, and thus may negatively affect their price. To investigate the potential devaluation of properties in Germany due to wind farm investments, we use a quasi-experimental technique and apply a spatial difference-in-differences (DID) approach to various wind farm sites in the federal state of North Rhine-Westphalia. We adopt a quantitative visual impact assessment approach to account for the adverse environmental effects caused by the wind turbines. To properly account for spatial dependence and unobserved variables bias, we incorporate different spatial econometric models into the DID analysis. The estimates indicate that the asking price for properties whose view was strongly affected by the construction of wind turbines decreased by about 10%. In contrast, properties with a medium or minor view on the constructed turbines experienced no devaluation.

Keywords: Wind power, Difference-in-Differences, Visual impact, Spatial dependence

JEL Classification: C31, Q2, Q42, R31

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I. INTRODUCTION

Over the last two decades, fostered by strong financial incentives, wind power in Germany has seen a rapid market diffusion. Guaranteed feed-in tariffs for renewable energies such as wind power often rewarded investors in these technologies with substantial economic returns. However, today's investment decisions in large-scale onshore wind power projects in Germany are no longer determined only by the investment's economic benefit, but also by the mitigation of public concerns and thereby the increase of social acceptance. Despite a mostly positive attitude towards the expansion of wind power, local public concerns often stem from the belief that the proximity to wind turbines diminishes property prices.

The proximity to a wind farm site may lead to various types of locally adverse effects, such as noise, sound pressure, electromagnetic inference, shadow flicker, as well as visual and scenic intrusion (Manwell et al., 2002). While noise, sound pressure, electromagnetic inference, and shadow flicker effects only occur in the immediate proximity to the wind farm (mainly within the first few hundred meters to the site), visual and scenic effects can have strong influences over considerable distances. Generally speaking, among the various locally adverse effects caused by wind farms, landscape and visual effects are considered to be the most dominant and relevant factors triggering public concerns (Andolina et al., 1998; van Beek et al., 1998; Gipe, 2002; Manwell et al., 2002; Benson, 2005; Miller et al., 2005). Wind farms, sited in predominantly rural areas, are usually visible from considerable distances, as these constructions tend to be significantly taller than any other object in the existing landscape (Miller et al., 2005). In addition, the average hub height and rotor diameter of wind turbines have increased tremendously over the last years, causing further changes in the landscape of the affected regions. The current trend of repowering (i.e. substituting older facilities by newer, larger, and more efficient ones) will continue to foster this development.

The visual impact threshold distance, i.e. the maximum distance from which a wind farm is visible, can be up to about 30 to 40 kilometers, depending on the terrain characteristics, landscape background, and weather conditions (Bishop, 2002; Sullivan et al., 2012). However, regarding the determination of thresholds of potential visual wind farm impacts, it is important to note that visibility cannot be regarded as a binary factor (i.e. only indicating if a wind farm is visible or not), but that the significance of the visual impact can vary within a spectrum that ranges from uninformed detection of the wind farm to strong visual disturbance (Bishop, 2002).[1] Therefore, in order to estimate the visual impact of a wind farm for different locations in a specific region, visibility has to be treated as a function of wind farm size and shape in relation to the observer's distance, the view angle to the object, the object's contrast in relation to its background, and atmospheric scattering (Bishop, 2002; Hurtado et al., 2004; Benson, 2005; Möller, 2006; Bishop and Miller, 2007; Molina-Ruiz et al., 2011; Manchado et al., 2013). Even if wind turbines are visible from distances of up to 30 or 40 kilometers under certain circumstances, usually the

[1] Bishop (2002) defines four visibility categories: uninformed detection, uninformed recognition, informed recognition, and informed visual impact. For further information on visual thresholds for detection, recognition, and visual impact, see also Shang and Bishop (2000).

significance of a visual impact can be expected to drop substantially beyond distances in excess of 2 to 3 kilometers (Bishop, 2002; Sullivan et al., 2012). Hence, visual impacts tend to be extremely complex and difficult to estimate quantitatively (Möller, 2006). However, in order to define reasonable threshold values for differentiated visibility levels, the distance to the wind farm and the number of visible turbines can be considered as the most important factors. Nonetheless, the literature on visual impact assessment of wind turbines almost entirely provides qualitative measures, and only very few publications so far focus on the development and application of quantitative measures of visual impacts (Hurtado et al., 2004; Möller, 2006; Torres-Sibille et al., 2009; Manchado et al., 2013; Kokologos et al., 2014).

As location is one of the most important determinants of a property's value, the proximity to environmental amenities and disamenities in the surroundings, and hence the associated preferences of the consumers, are supposed to be indirectly reflected in its value. The assessment and quantification of changes in the locational attributes of a given property (e.g. due to the construction of a wind farm in the proximity) can be implemented by means of the hedonic pricing method, which allows for the extraction of the implicit price of one attribute from the overall price of the property (Rosen, 1974; Parmeter and Pope, 2013).

Applied to the case where the change in the locational attributes of a property is caused by the construction of a wind farm, the extraction of the attributes' implicit price demands for a suitable and differentiated representation of the wind farms' influence on the location of the property. As the impact on landscape and view can be considered as the most dominant wind farm effect, studies aiming at a precise and reliable estimation of potential local impacts of wind farms on property values in the surroundings should rely on an explicit incorporation of visibility effects. Still, most studies only apply simple distance measures as proxies for all kinds of local wind farm effects (see section II), and do not actually account for more precise estimates of actual visibility changes.

The aim of this study is to investigate local visual impacts of wind farms on the development of property prices by explicitly implementing direct visibility estimates in the analysis. Four large-scale wind farm sites located in the immediate vicinity of three medium-sized cities in the federal state of North Rhine-Westphalia (NRW), Germany, are investigated. Within the framework of the hedonic pricing method, we apply a spatial difference-in-differences (DID) model that allows for a comparison of the observed changes in the values of the treated properties against the values of a control group. Applied to the case of wind farm construction, the treatment and control groups are defined according to various wind farm visibility criteria (see section III).

Quasi-experimental approaches, such as the DID approach, are increasingly applied in hedonic pricing analyses. They offer a straightforward way to estimate causal relationships and often ensure better estimates compared to the ones obtained via standard hedonic pricing approaches (Bertrand et al., 2004; Kuminoff et al., 2010).[2] The advantages of applying a quasi-experiment within the framework of the hedonic pricing theory is most evident in relation to empirical deficiencies in traditional hedonic applications, such as the inability to control for endogenous

[2] For further information on advantages of the DID framework over other approaches, see Kuminoff et al. (2010) and Parmeter and Pope (2013).

influences and omitted variable bias (Parmeter and Pope, 2013). The DID framework is particularly well suited for the application to our study case, as it enables us to control for interferences that either exist in the given region prior to the siting of the wind farm, or that affect all properties irrespective of the wind farm construction (Lang et al., 2014).

For the purpose of investigating visual impacts of wind farms, we partially adapt the quantitative visual impact measurement approach proposed by Hurtado et al. (2004) and develop a factor-based 'Visual Impact Level' (*VIL*) ranking incorporating the magnitude of visibility (i.e. the number of visible turbines), the distance to the wind farm, and the view angle from the center of the property. As mentioned above, besides the incorporation of distance, magnitude of visibility, and view angle, visual impact assessments should ideally also consider weather conditions, atmospheric scattering, and background contrasting. However, due to limited data availability and computational issues, accounting for these factors is beyond the scope of this analysis. Nonetheless, thanks to the implementation of a quantitative factor-based approach considering the relation of distance, magnitude of visibility, and view angle, we improve the current practice of applying qualitative-subjective evaluations of visual impacts in hedonic pricing analysis. More specifically, the impact of the different visibility levels on the property values is estimated by means of a Spatial Fixed Effects model, a Spatial Auto-Regressive Lag Model with an Auto-Regressive Error Term (SAC/SARAR)[3], and a Spatial Durbin Error Model (SDEM).

The hedonic pricing literature on wind farm effects is still sparse and only contains a few peer-reviewed, econometrically sound analyses (see section II). The main weaknesses that can be identified in many such studies are related to (1) an insufficient representation of wind farm impacts through simple distance measures that are used as proxies for visual impacts, (2) a rarely systematic and mostly subjective determination of visual impacts (if at all incorporated), and (3) a missing explicit account of spatial dependence by means of spatial econometric methods. We address (1) and (2) through the systematic determination of different *VILs* that explicitly consider the relationship between distance, the degree of visibility, and the view angle. The defined *VILs* are based on viewshed analyses that use high-resolution 3D data with an accuracy of one square meter, and that include, in a digital surface model, all visible elements in the environment, such as heights, slopes, vegetation, and buildings. We approach (3) by applying a Spatial Fixed Effects Model, a SAC/SARAR, and a SDEM in the DID framework (see section IV).

Additionally, while most studies focus on wind farm effects in the US, our research is one of the first comprehensive analyses for Europe and, more specifically, Germany. The insights gained from our analysis may thus be of particular relevance, also in light of differences in the property market conditions and spatial dimensions between Germany and the US, which imply that the results obtained cannot simply be assumed to hold true irrespective of the region considered.

The remainder of this paper is structured as follows. Section II provides an overview of the previous research on wind farm impacts on property values using a hedonic pricing framework.

[3] In the literature, the spatial auto-regressive lag model with an auto-regressive error term is labelled as SAC (LeSage and Pace, 2009) as well as SARAR (Kelejian and Prucha, 1998).

Section III introduces the visual impact assessment, which is then incorporated into the spatial DID framework presented in section IV. Section V presents the results obtained from the different model specifications, and section VI concludes by summarizing the main insights from our analysis.

II. Previous Research

To date, the number of publications that investigate the impact of wind farms on property values by means of hedonic pricing methods is still limited. Despite the limited number of publications, there is considerable variety of approaches regarding the selection of suitable variables (particularly with respect to the choice of the most appropriate proxy for wind farm impacts), estimation techniques (mainly with regard to possible omitted variable biases and spatial dependence), and applications (e.g. in view of single-turbine vs. large-scale wind farm cases). In the following, we highlight the main features of each study, while focusing on how wind farm effects are implemented and also how spatial dependence is accounted for.

Being among the earliest published studies on this topic, Sims and Dent (2007) as well as Sims et al. (2008) investigate the impacts of wind farms on house prices in Cornwall, UK. Sims and Dent (2007) apply a simplistic regression approach that does not control for any spatial effects in the data. Various distance zone dummies are used as proxies for wind farm impacts. Furthermore, the authors consider only property sales between 2000 and 2004 that took place after the construction of the wind farm, which is by far the most problematic issue. Sims et al. (2008), in contrast, consider the problem of spatial relationships in the data by using spatial fixed effects. Furthermore, they incorporate some dummy variables indicating visibility. However, they do so without considering any actual relation to distance or extent of visibility. The data base is again rather small (199 property sales), though it considers a longer time interval (2000-2007). In general, both Sims and Dent (2007) and Sims et al. (2008) could not obtain any significant evidence of the effects investigated, though this outcome might have been strongly influenced by the limitations in the analysis carried out.

Hoen et al. (2009, 2011) and Hoen et al. (2013) analyze wind farm impacts on various sites in the US and provide by far the most comprehensive studies currently available in the literature. In a published article version of their project report (Hoen et al., 2009), Hoen et al. (2011) investigate about 7,500 single-family house sales in the period between 1996 and 2007 in the proximity of 24 large-scale wind farm sites spread across nine US states. In their study, they explicitly focus on visibility effects and develop an ordered qualitative visual impact ranking system that incorporates distance to the turbines, the number of turbines visible, as well as the view angle. To approve the subjectively designed visual impact ranking, they conducted a pre-study survey based on an evaluation of randomly selected site photographs by respondents and checked for correlations between the qualitative ranking and the measured values (i.e. distance, number of turbines visible, view angle) using a regression model. Within a standard hedonic framework, different model specifications were applied, also accounting for spatial autocorrelation via spatial fixed effects and nearest neighbor weights (similar to a spatial lag model). According to the results obtained, no evidence was found for visual impacts or other wind farm-related effects in the considered study areas. Hoen et al. (2013) further improved the two aforementioned studies by applying a DID framework with spatial econometric methods in order to control for spatial dependence. With more than 50,000 property sales from 1996 to 2011 in a 10 miles radius around 67 wind farm sites in nine US states, this report is to date one of the most extensive and well-designed analyses. However, instead of further developing a visual impact ranking based on quantitative measures, rather than only qualitative ones, they simply used distance ranges as proxies for visual influences and other local impacts. Similar to the studies before, they found no statistically significant wind farm construction impacts on property values.

A similar approach was recently adopted in a report by Atkinson-Palombo and Hoen (2014), who investigate potential wind farm impacts on properties in Massachusetts, US. The study specifically focuses on noise and shadow flicker effects within half a mile around the considered properties in more densely populated urban areas. The extensive dataset accounted for 122,000 home sales between 1998 and 2012. Again, a simple distance variable controlled for possible local effects. Spatial relationships in the data were again addressed via spatial fixed effects and nearest neighbor weights. The results obtained did not provide any significant evidence for local wind farm effects caused by the construction or announcement of the projects.

Sunak and Madlener (2012) investigate the impacts of wind farms on property values in Germany by means of different spatial fixed effects specifications and a locally weighted regression model. Besides the estimation of wind farm impacts via a continuous distance variable as well as distance range dummies, visibility is explicitly analyzed in a fixed viewshed effect specification and the locally weighted regression model. The dataset includes 1,405 observations in a period ranging from 1992 to 2010. Overall, some evidence was found for negative impacts on property prices in cause of the wind farm construction.

Heintzelman and Tuttle (2012) provide a wind farm analysis in a standard hedonic framework and apply a spatial fixed effects specification. Wind farm effects are incorporated in the models solely using continuous distance and distance range variables, whereas visibility is not considered. Including about 11,000 property sales occurred in the time period between 2000 and 2009 in northern New York, US, the results indicate statistically significant negative impacts on property prices.

Most recently, Lang et al. (2014) conducted an analysis on the impact of 12 single turbines on property values (48,554 observations) in 10 different sites in the time period between 2000 and 2013 in Rhode Island, US. Applying a DID framework, they incorporate various distance bands around the turbine sites in order to investigate construction and announcement effects. In a further specification of the model, they also apply a qualitative visual impact ranking to examine potential wind farm visibility effects. Spatial relationships in the data are addressed by the implementation of spatial fixed effects, whereas spatial dependence is not considered in their analysis. Although the modeling design and the econometric implementation are elaborate and sound, there are some drawbacks associated to the study objects chosen and the wind farm impact proxies applied. Firstly, in contrast to all other studies that investigate the impacts of large-scale wind farms on surrounding properties, Lang et al. (2014) only focus on single and relatively small turbines. This might affect the significance of their results when compared to studies that consider large-scale farms (e.g. with more than 15 or 20 turbines), which possibly have a stronger impact on landscape and view and thus property prices, *ceteris paribus*. Secondly, even though visual impacts are considered in one model specification, the visual impact classification is solely based on the subjective opinion of one individual that conducted all the field visits. A more systematic approach to rank the data, e.g. relating distance and extent of visibility, would have benefited the study.

Table 1 provides an overview of the studies discussed and their main features.

TABLE 1: Overview of studies discussed and their features

	Study area	***N***	**Time period**	**Object of study**	**Model framework**	**Spatial methods**	**Wind farm effect proxy**	**Impact estimation**
Sims and Dent (2007)	UK	919	2000-2004	Wind farm	Standard hedonic	-	Distance	Negative
Sims et al. (2008)	UK	119	2000-2007	Wind farm	Standard hedonic	SFE	View	None
Hoen et al. (2009, 2011)	US	7,459	1996-2007	Wind farm	Standard hedonic	SFE, Spatial lag	Qual. view ranking	None
Hoen et al. (2013)	US	51,276	1996-2011	Wind farm	DID	SFE, SARAR	Distance	None
Atkinson-Palombo and Hoen (2014)	US	122,198	1998-2012	Wind farm	Standard hedonic	SFE, Spatial lag	Distance	None
Sunak and Madlener (2012)	GER	1,405	1992-2010	Wind farm	Standard hedonic	SFE, LWR	Distance + View	Negative
Heintzelman and Tuttle (2012)	US	11,369	2000-2009	Wind farm	Standard hedonic	SFE	Distance	Negative
Lang et al. (2014)	US	48,554	2000-2013	Single turbines	DID	SFE	Distance + Qual. view ranking	None

III. VISUAL IMPACT ASSESSMENT

Visual Impact Levels

The implementation of a precisely measured and representative proxy for local wind farm effects is crucial for hedonic pricing studies that aim at estimating potential impacts of wind farms on property values. As already indicated above, changes in landscape and view due to the construction of wind farms are the most significant factors and should, therefore, be directly accounted for. Simple distance measures (i.e. grouping property sales according to their distance to the nearest turbine) can only provide a crude representation of local wind farm effects. Likewise, the application of binary visibility variables (i.e., only indicating if a wind turbine is visible or not) may not adequately represent the visual effects caused by wind farm sites. The visual impact of wind farms is rather a function of various factors that affects a specific location, and may include the distance to the nearest turbine, the number and extent of turbines visible, and the observer's view angle.

As described in section II, only two studies adopt qualitative rankings in order to determine the visual impact for each property location. Hoen et al. (2009, 2011) develop a five-categories ranking based on the following wind farm visibility scale from a given property: (1) no view, (2) minor, (3) moderate, (4) substantial, and (5) extreme view. While the classification is not based on values for distance, number of turbines, or view angle, but rather on subjective considerations, at least the ranking is substantiated by a survey and some correlation tests. Lang et al. (2014) also apply a similar approach, yet no quasi-quantitative validation is conducted[4]. Their visual impact assessment is merely based on the individual ratings by a single person who was in charge of conducting all the field visits to properties within two miles around the considered turbine site.

In order to improve the previously applied qualitative approaches to incorporate different levels of visual impact in hedonic pricing studies, we adopt the quantitative, indicator-based visual impact assessment methodology provided by Hurtado et al. (2004), which was further developed by Kokologos et al. (2014). Originally, this approach was proposed to quantify the visual impact of wind farms for site pre-assessment and to evaluate the overall visual impact across whole regions. We apply and adapt the coefficient-based measurements to our study case, hence determining the *VIL* for each considered property in our data set. In addition, we validate the method by considering other proposed approaches and findings in this field (Bishop, 2002; Torres-Sibille et al., 2009; de Vries et al., 2012). The procedure adopted to determine *VIL* for each property is described in the following.

The applied visual impact assessment method is based on five indicators: the visibility of the wind farm from the city area, a, the visibility of the city area from the wind farm, b, the number of visible turbines in relation to the view angle, c, and the distance of the wind farm from the specific location in the city area, d. While the indicators a and b provide a more general characterization of the regional context, and indicate the overall relation of the wind farm to the different cities and city districts, respectively, indicators c and d measure the exact influence on

[4] The visual impact classes used in their study encompass (1) no view (0%), (2) minor (1-30%), (3) moderate (31-60%), (4) high (61-90%), and (5) extreme (91-100%).

the single property. Even though the main focus lies on the measurement of visual impacts at the single property level (through *c* and *d*), a rather general weighting of different regional effects through indicators *a* and *b* is also important. This needs to be accounted for, as the different cities and city districts in our study area are subject to substantially varying wind farm effects, given that, among other things, the southern part of the study area is affected by about 50 turbines overall and the northern area only by nine (see Figure 1).

The visibility of the wind farm from the city area *a* is given by

$$a = \frac{\sum_{i=1}^{n}\left(\frac{T_i}{WF}\right)}{n}, \quad [1]$$

where *n* is the number of areas inside the city/city district with different views of the wind farm, T_i is the number of visible turbines from this considered area *i*, and *WF* is the total number of turbines in the wind farm.

The visibility of the city area from the wind farm *b* (independent from *a*) is determined by

$$b = \frac{\text{number of properties visible from the wind farm}}{\text{total number of properties in the city district}}. \quad [2]$$

The extent of visibility for each location is specified by

$$c = vt \times va, \quad [3]$$

where *vt* provides the factor for the number of visible turbines and *va* defines the factor for the different view angles to the wind farm (see Table 2 and Table 3, respectively).

TABLE 2: Distribution of factor parameters according to the number of visible turbines

Number of visible turbines	*vt* factor
1-3	0.50
4-10	0.90
11-20	1.00
21-30	1.05
> 30	1.10

Source: Hurtado et al. (2004)

TABLE 3: Distribution of factor parameters according to the view angle to the wind farm

View angle	***va* factor**
Frontal	1.00
Diagonal	0.50
Longitudinal	0.20

Source: Hurtado et al. (2004)

Finally, Table 4 provides the coefficients for the distance of the properties to the turbines of the nearest wind farm (indicator *d*).

TABLE 4: Distribution of the coefficients of indicator *d* according to the distance to the nearest turbine

Distance *x* [m]	***d* coefficient**
$x < 500$	1.00
$500 < x < 6000$	$1.05 - 0.0002 \times x$
$x > 6000$ (if turbine is visible)	0.10

Source: Hurtado et al. (2004)

Consolidating the defined indicators for the visual impact assessment, the visual impact *VI* for the different properties in the study area is given by

$$VI = a \times b \times c \times d\,.^{5} \qquad [4]$$

By applying the procedure described, a visual impact coefficient between 0 (no impact) and 1 (highest impact) was assigned to each property in the dataset. In order to validate the applied factors and coefficients, we compared them to those used in other visual impact assessment studies in the literature. Overall, we found that the defined factors and their coefficients largely correspond to those applied in other studies. For instance, De Vries et al. (2012) conducted a survey based on photographs of different scenic situations involving the siting of wind farms, where the visual impact depends on distance, the number of turbines, turbine height, and the design of the wind farm. They found that wind turbines located at a distance of 2,500 meters cause about half the impact of turbines located in a 500 meters range. Regarding the coefficients used in Table 4 to determine factor *d*, the decreasing impact in distance coincides with the findings of De Vries et al. (2012) and is consistent with the probabilities of visual impact shown by Bishop (2002) and Sullivan et al. (2012), respecitely. Furthermore, Torres-Sibille et al. (2009) emphasize the importance of the number of turbines visible in relation to the degree of visibility, which in our case is represented by factors *a* and *c*.

[5] In a further step, Hurtado et al (2004) also define an additional factor *e* that indicates the number of people living in the areas affected. As in our case the adaption of the method aims at the determination of impact levels on a single property scale, factor *e* is omitted.

The required data for applying the visual impact assessment to our case study is derived by applying various tools from the ArcGIS software.[6] The measurements of visibility (the areas from where the wind turbines are visible), the distance to the nearest wind farm, and the view angle were estimated on the basis of a high-resolution digital surface model provided upon request by the geodata office of the federal state of NRW (Geobasis Datenportal NRW)[7]. With an accuracy of one square meter (more than 250 million data points), the digital surface model included information about the height level of the terrain, vegetation characteristics, and building types. The use of this digital surface model enables a precise identification of all areas from where the wind farm is visible by means of a viewshed analysis, and which includes all landscape features (e.g. heights, slopes, vegetation, or buildings) that help determine a precise account of the view from a specific location.

In a last step, based on the visual impact assessment for each property, we assigned each property to one of the six *VILs* provided in Table 5. The different steps of the coefficient range that determine the *VILs* are defined based on natural breaks given the number of six levels. The number of the impact levels also corresponds to a large extent to the ranking applied in Hoen et al. (2009, 2011) and Lang et al. (2014), respectively. In addition, Table 5 provides an overview of the number of observations for each level and a percentage value in relation to the total amount of the relevant observations. As visual impact can only be measured after the wind farms are built, the number of relevant observations reduces to 905 out of a total of 2,141 property sales in the dataset. Overall, a substantial visual impact (*VIL VI* and *VIL V*) could be detected for about 22% of the properties considered (197). The developed *VILs* represent the 'wind farm treatment' that is estimated by means of the spatial DID model, as described in section IV.

TABLE 5: 'Visual Impact Levels' and the distribution of observations

VIL	**Visibility**	**Coefficient range** [$a \times b \times c \times d$]	**No. of observations** [$VIL \times PT$]
VI	Extreme	1 – 0.8	63 (7.0%)
V	Dominant	0.8 – 0.6	134 (14.8%)
IV	Medium	0.6 – 0.4	150 (16.6%)
III	Minor	0.4 – 0.2	182 (20.1%)
II	Marginal	0.2 – > 0	122 (13.4%)
I	No view	0	254 (28.1%)
			905 (100%)

Data description

The study area chosen for our analysis has an extent of about 285 km² and is located in the northern part of the federal state of NRW, Germany. This area can be characterized as a relatively

[6] We use ESRI's ArcGIS Spatial Analyst, Spatial Statistics, and 3D Analyst tool in version 10.2.

[7] Further information on the data offered by the Geobasis Datenportal NRW are available online at https://www.geodatenzentrum.nrw.de/ASWeb34_GBDP/ASC_Frame/portal.jsp, accessed June 24, 2014.

flat semi-urban region. In order to investigate potential adverse visual impacts caused by the constructed wind farms in this location, we obtained arm's length property sales data for the three medium-sized cities of Steinfurt, Neuenkirchen, and Rheine. Each of the three cities comprises two city districts: Steinfurt is comprised of Borghorst and Burgsteinfurt, Neuenkirchen consists of Neuenkirchen (city) and St. Arnold, and Rheine's city districts are Mesum and Hauenhorst.[8] The property sales data was provided upon request from the regional Expert Advisory Boards (Gutachterausschüsse) on behalf of the regional administrations. The property sales data contained 2,141 registered sales for the time period between 1992 and 2010. Besides the selling price and selling date for each property, the data also contained the size of the parcels, the address-based location as well as the type and development status of the properties. In order to account for the inflation effect, all sales in the dataset were adjusted according to the German Construction Price Index with 2005 as its base year.[9]

Due to a relatively strict data privacy regulation for address-based property price data in Germany, the regional Expert Advisory Boards granted us access to property prices in terms of prices for parcels of land. The actual house prices could not be disclosed. Even though, according to the German building law, all property sales (homes plus parcels) have to be reported to the respective regional Expert Advisory Board (and are therefore available there), the dataset only consists of land parcel sales, separated from the price of the home, due to the prevailing privacy restrictions. Nevertheless, the obtained property sales data encompass arm's length transactions of parcels for residential utilization only and is, therefore, unconditionally suitable for the study's purpose.[10] Table 6 provides an overview of the distribution of property sales according to the different city districts.

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[8] In the following, we always refer to the city districts.

[9] The German Construction Price Index is published by the German Federal Statistical Office and made available online at https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2013/04/PD13_132_61261.html, accessed April 2, 2014.

[10] The data used only considers properties (i.e. parcels of land) that are assigned for residential utilization according to the regional development plan of the regional administration. We are aware of the problem that wind farms are usually located on land with lower values and that, in this case, using land prices for this type of analysis can lead to biased estimates. This might likely be the case if, for instance, agricultural land prices are considered, as wind farms in Germany are almost entirely sited on agricultural parcels of land. However, a land parcel for residential utilization can, by law, not be utilized for wind farm development in Germany. In the light of the aforesaid, no restraints should be given in order to identify the pure effect of wind farms on property values using residential land price data. Furthermore, as we only consider parcels for residential utilization, the parcels are mostly square-shaped, given that homes have to be built on these parcels. Therefore, differences in prices that may arise from the difference in the shape of the parcels, such as wide or narrow frontage parcels, can be safely neglected.

TABLE 6: Distribution of property sales in the study area between 1992 and 2010

	N
Total number of property sales	**2,141**
Before treatment (*BT*)	1,236
Post treatment (*PT*)	905
Steinfurt	**939**
District Borghorst	561
District Burgsteinfurt	378
Rheine	**603**
District Mesum	406
District Hauenhorst	197
Neuenkirchen	**599**
District Neuenkirchen (city)	466
District St. Arnold	133

Four wind farms of different sizes and configurations are located in the study area. Figure 1 illustrates the location of the wind farm sites as well as the property sales (and their respective *VILs*) in the study area. The construction of the wind farm in the northern part of the area, located near the city districts of Neuenkirchen, St.Arnold, Hauenhorst, and Mesum was announced in the year 2000 and was completed in July 2002. The wind farm consists of nine 1.5 MW turbines with hub heights of 100 meters and rotor sizes of 77 meters. A second site with 19 turbines is located in the proximity of Burgsteinfurt. The turbines built here, each with a capacity of 1.5 MW, have a hub height of 100 meters and rotor diameters of 77 meters (in two cases the rotor diameter reaches a span of 92 meters). The wind farm construction was announced in October 2000 and it has been in operation since December 2001. The smallest wind farm site in the eastern part of the study area near Borghorst has a total capacity of 7.5 MW, thanks to five 1.5 MW turbines with hub heights of 85 meters and rotor diameters of 77 meters. It was announced in October 2000 and finally built in April 2001. Lastly, the largest wind farm site is located in the southern part of the area studied, and consists of 26 turbines, each with an installed capacity between 1 and 1.5 MW, hub heights of 85 to 100 meters, and rotor diameters of 77 to 92 meters. The wind farm construction was first announced in early 2000 and it has been in operation since September 2001.

In the dataset, there are considerable differences with respect to visibility and distance from the properties considered. The number of turbines visible to a single property may range from 0 to 30, while the distance to the nearest wind turbine may vary from a minimum of 726 meters to a maximum of almost 6,000 meters. Thus, the spatial distribution of the properties' *VILs* also varies substantially across the area under study (see Figure 1). Extreme and dominant impact levels are mainly limited to the areas with an unobstructed view in the immediate proximity of wind turbines (e.g. southern Borghorst, northern Burgsteinfrut, and St. Arnold) and at the city limits, where the view is also likely unobstructed (south-western Borghorst). Areas further away from the wind farm, but within the city limits, such as the south-eastern part of Neuenkirchen, still show medium *VILs*. The visual impact mostly appears to fade towards the city centers, as higher building-density increasingly tends to obstruct the view from a given property. In Hauenhorst and

Mesum, mainly due to the long distance and the diagonal angle towards the turbines, the visual impact is mostly minor or even marginal.

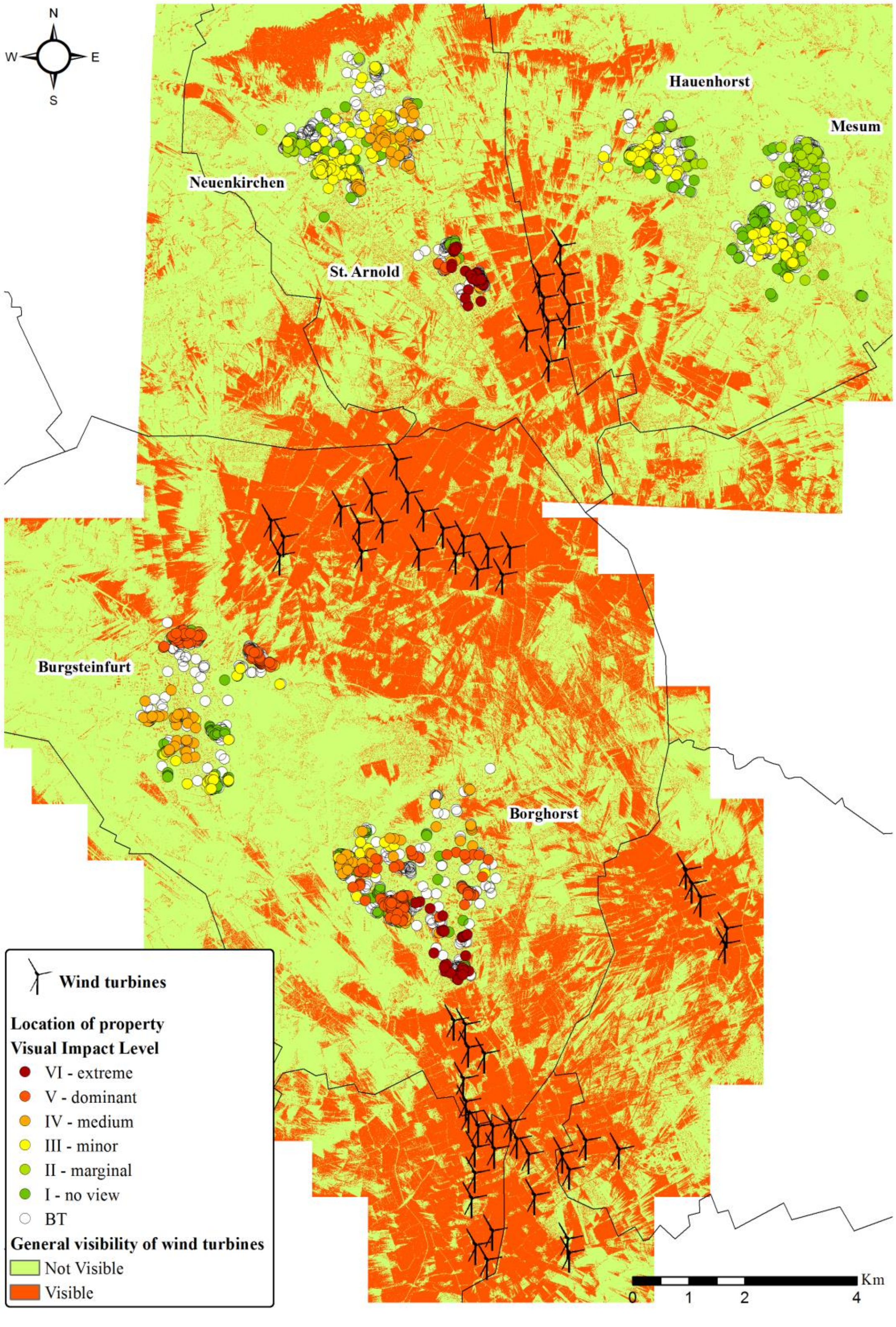

FIGURE 1: Wind farm visibility

Besides the wind farm-related variables of interest, we also included various structural and neighborhood variables that need to be controlled for in hedonic pricing studies. Table 7 provides an overview of descriptive statistics for these variables.

TABLE 7: Descriptive statistics of the structural and neighborhood variables

Variable *	Mean	Std. dev.	Min	Max
ln *p*	10.58	0.70	4.34	12.74
ln *Parcel size*	6.24	0.58	1.10	9.83
Waterfront	0.00	0.07	0	1
Type single-family house	0.62	0.48	0	1
Type duplex house	0.18	0.38	0	1
Type row house	0.02	0.15	0	1
Type multi-family house	0.03	0.17	0	1
ln (*Dist. to CBD*)	-6.82	0.95	-8.28	2.30
ln (*Dist. to Supermarket*)	-6.24	0.58	-7.45	-3.52
ln (*Dist. to Commercial area*)	-6.55	1.25	-8.65	2.30
ln (*Dist. to School*)	-6.33	0.82	-8.01	-4.25
ln (*Dist. to Forestland*)	-5.41	0.87	-6.65	2.30
ln (*Dist. to Major road*)	-5.23	0.89	-6.90	-1.97
ln (*Dist. to Road*)	-2.46	0.40	-4.53	-0.02
Street noise	0.26	0.64	1	5
ln (*Dist to. Railroads*)	-6.83	1.38	-8.91	-3.28
ln (*Dist. to Transmission line*)	-6.73	0.84	-7.72	-2.90
ln (*Dist. to Lake*)	-6.25	0.66	-7.52	-3.23

* *Notes*: The semi-log specification applied has the advantage that it allows for an intuitive interpretation of the results obtained, so that the estimated coefficients of the independent variables can be interpreted as elasticities (Gujarati and Porter, 2009, p.162). The estimated coefficients of the dummy variables can be interpreted as median impacts (Gujarati and Porter, 2009, p.298). Furthermore, the semi-log specification reduces heteroscedasticity (Gujarati and Porter, 2009, p.394). The variables indicating the distance to amenities/disamenities are Euclidean (inverse) distance measures. Using an inverse measure of distance, the measured values increase with decreasing distance. This allows for a direct interpretation of coefficient estimates regarding their signs and magnitude.

It should be mentioned that the set of structural variables includes the property's sales prices, the parcel size, and the development status of the property. The different development status encompass a differentiation between undeveloped/untilled parcels and developed parcels, where the developed ones are again subdivided according to the type of residential building (i.e. single-family house, duplex house, row house, and multi-family house). We estimate the impact of those development statuses relative to the case of an undeveloped parcel. Furthermore, the neighborhood variables mainly comprise distance measures that represent the location of each property. Data on the location of the various amenities and disamenities in the region are obtained from different sources.[11] Based on these, we were able to calculate the Euclidean (inverse) distances by means of tools provided in the ArcGIS toolbox.

[11] The location of the amenities and disamenities are, on the one hand, derived from the geodata obtained from the Geobasis Datenportal NRW, and, on the other hand, provided upon request from the different statistical offices on the state level (federal statistical office of NRW) and regional level (regional/city administrations), respectively.

IV. SPATIAL DIFFERENCE-IN-DIFFERENCES FRAMEWORK

To examine the potential devaluation of properties that have obtained a change in vista in consequence of the construction of a wind farm, we use a quasi-experimental technique and apply a spatial DID approach. The latter allows for a comparison of the observed changes in the values of the treated properties against the values of a control group (Greenstone and Gayer, 2009; Heckert and Mennis, 2012; Parmeter and Pope, 2013).

First, it is necessary to identify the exogenous change (i.e. treatment, e.g. through the introduction of a policy) in one environmental attribute, which is ultimately expected to have an impact on property prices. Importantly, the quasi-experimental approach requires that such exogenous change happens at an unexpected point in time from the viewpoint of the property owner (Parmeter and Pope, 2013). In addition, the development of a quasi-experimental analysis framework requires an understanding of how spatial influences and the timing of the exogenous change are related to the property market (Parmeter and Pope, 2013). Second, in order to investigate this exogenous change when applying a DID framework, data is needed that contain property sales for the areas that are affected by the introduction of the policy (i.e. the exogenous change) as well as data for an unaffected control group. Most importantly, besides the impact of the exogenous change that only occurs in some areas, the properties in the different areas have to be similar, if not identical, regarding their characteristics.

In our model, the treated properties (treatment group) are defined as those with a direct view on the wind farm, while the properties which experienced no treatment (control group) are those without a view on the constructed wind farm. The treatment and control groups are determined by an interaction term that indicates the visual impact and the time of construction of the wind farm. Thus, in the period between 1992 and 2001 (pre-construction phase) all properties can be considered as part of the control group, while after 2001 (post-construction phase) only the group with a direct view on the wind farm is considered to belong to the treatment group.[12] Figure 2 provides an overview of the quasi-experimental approach and the creation of the treatment and control group.

[12] In the literature often also the possible effects of the announcement of a wind farm project are investigated. In our case, there are two reasons not to include the effect of announcement as a treatment. Firstly, as we consider visual impact levels, those are directly related to the physical construction of the wind farm. Therefore, the visual impact cannot be sufficiently predicted before the wind turbines are actually built, even if the wind farm is announced with project plans that indicate the location, size and shape of the future wind farm. Secondly, only very few transactions occurred in the relatively short period between announcement and construction of the wind farms, which in the end do not provide a reliable basis for including the announcement as a treatment.

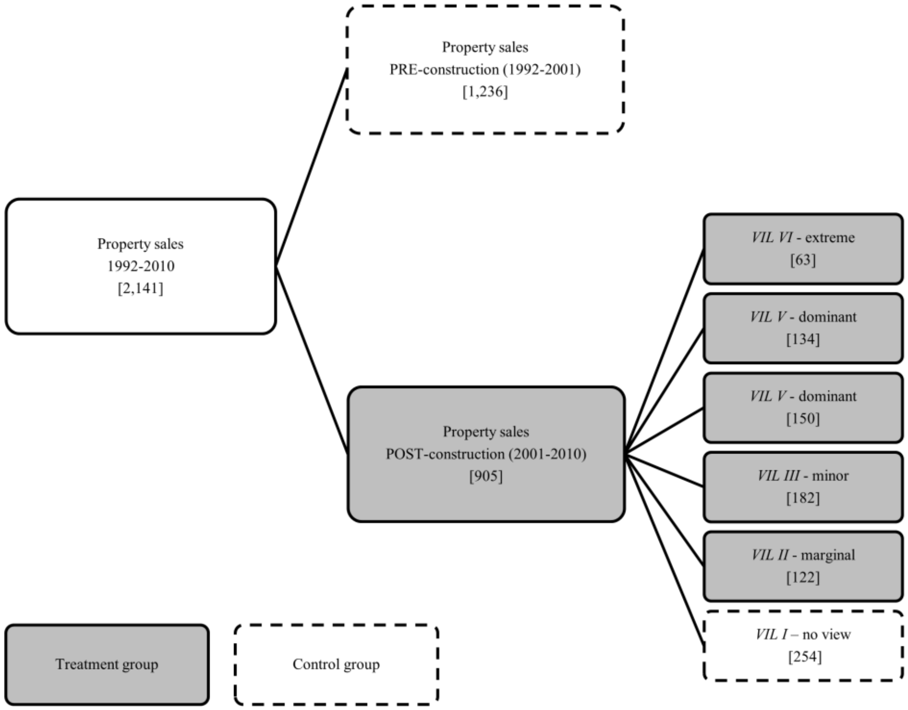

FIGURE 2: Treatment and control group

In order to investigate the impact of different *VILs* on property values in the DID framework proposed, we apply three spatial estimation techniques that differently account for spatial dependence and spatial heterogeneity: (1) a spatial fixed effects model, (2) a SAC/SARAR, and (3) a Spatial Durbin Error Model. In all three models, the coefficients obtained for the interaction between the *VIL* variables and the variable indicating if the transaction occurred post construction are of particular interest (DID estimator: *VIL×PT*).

The first most commonly used standard estimation approach in hedonic pricing studies is the spatial fixed effects model specification. By incorporating dummy variables that indicate, for instance, the city district where the property is located, those spatial fixed effects implicitly pick up any spatially clustered unobserved influences in a given district. The advantage of this specification is its prevention of a misspecification bias due to omitted variables, which explains why this straightforward technique is often applied in hedonic pricing frameworks (see Table 1). A more formal representation of this estimation technique, as applied to our model framework, is the following:

$$\ln\left(p_i\right) = \alpha_i + \delta_i + \sum_{k=5}^{VIL} \beta_1 VIL_{k,i} + \sum_{k=5}^{VIL} \beta_2 PT_i + \sum_{k=5}^{VIL} \beta_3 \left(VIL_{k,i} \times PT_i\right) + \beta_4 X_i + \varepsilon_i, \qquad [5]$$

where $\ln(P_i)$ is the sales price of property i, α_i represents the spatial fixed effects for property i (i.e. the city district), δ_i expresses the temporal fixed effects indicating the time when property i was sold (controlling for annual and monthly variations), $VIL_{k,i}$ indicates the k^{th} level of visual impact for property i, PT_i is a dummy variable equal to unity if property i was sold post wind farm construction, $VIL_{k,i} \times PT_i$ is the already mentioned DID estimator that measures the impact of the $VIL_{k,i}$ in the treatment group (properties that were sold in period *PT*), X_i a vector containing the set of other structural and neighborhood variables, and ε_i is the error term. The estimates for β_1 can be interpreted as a measure for *ex-ante* treatment differences in property prices for the k^{th} *VIL* relative to *VIL I*, β_2 is the coefficient indicating differences in the control group in the treatment period, β_3 is the coefficient of interest that measures the difference in property prices development for the k^{th} *VIL* relative to *VIL I* as result of the wind farm construction, and β_4 is the coefficient measuring the influence of structural and neighborhood variables on the property price variation.

Although the incorporation of spatial fixed effects mitigates the bias caused by spatially clustered unobserved variables, its ability to sufficiently account for spatial dependence remains empirically spurious (Anselin and Arribas-Bel, 2013). Spatial dependence, not sufficiently controlled for, might lead to biased and/or inefficient estimates (Anselin, 1988; Anselin and Getis, 2010). In order to incorporate spatial dependence, the literature suggests different models that allow for capturing unobserved spatial characteristics by means of the inclusion of spatial lags in the dependent variable, the explanatory variable, and the error term (LeSage and Pace, 2009). From an empirical perspective, strong motivation to apply spatial econometric techniques is provided given the potentially simultaneous presence of spatial dependence and spatially clustered omitted variables (Lerbs and Oberst, 2014). Given the strength of spatial dependence in the dependent variable, the explanatory variables and the error term, the omitted variable bias can be intensified if the included explanatory variables and any omitted spatial effects exhibit a non-zero correlation (Pace and LeSage, 2010). In this context, we estimate the following model specifications that explicitly account for spatial dependence in the dependent variable ($\ln(P_i)$), the explanatory variables ($VIL_{k,i}$, PT_i, X_i), and the error term (ε_i).

Firstly, in order to account for potential spatial dependence in the dependent variable versus the error term, we estimate a spatial auto-regressive lag model with an auto-regressive error term model (SAC/SARAR), which takes the form

$$\begin{aligned} &\ln\left(p_i\right) = \rho W \ln\left(p_i\right) + \delta_i + \sum_{k=5}^{VIL} \beta_1 VIL_{k,i} + \sum_{k=5}^{VIL} \beta_2 PT_i + \sum_{k=5}^{VIL} \beta_3 \left(VIL_{k,i} \times PT_i\right) + \beta_4 X_i + \mu_i \\ &\mu_i = \lambda W \mu_i + \varepsilon_i \end{aligned}, \qquad [6]$$

where all variables and coefficients are equal to those introduced in eq. [5]. The difference compared to eq. [5] lies in the underlying spatial process given by *W*, which represents an $N \times N$ row-stochastic spatial weight matrix indicating the spatial relationship between the observations. The estimation *W* is based on the spatial proximity among the properties. Following Tobler's First Law of Geography (Tobler, 1970), we use a spatial weight matrix (*W*) based on a *k*-nearest neighbor inverse distance. The latter assumes a decreasing spatial influence as the distance between two properties increases. In the case study applied here, *W* is calculated for the first 10 nearest neighbors of each observation. Furthermore, ρ and λ are the scalar parameters denoting the spatial dependence in the dependent variable and the error term, respectively. As the

SAC/SARAR simultaneously combines both a Spatial Lag and Spatial Error model, it reduces to a Spatial Error model if ρ=0, and to a Spatial Lag model if λ=0.

Secondly, in the presence of unobserved, spatially dependent local characteristics, the inclusion of spatial lags in the explanatory variables should also be considered (Lerbs and Oberst, 2014). Since the SAC/SARAR does not allow for the inclusion of this type of spatial dependence, the literature suggests the application of a Spatial Durbin Model (SDM) (Pace and LeSage, 2010; Elhorst, 2010). The SDM combines the incorporation of spatial dependence in the explanatory variables, with either a spatial lag in the dependent variable or in the error term. In our case, the SDM is combined with a spatially auto-regressive error term and becomes, therefore, a Spatial Durbin Error Model (SDEM). The SDEM is given by

$$\begin{aligned} &\ln\left(p_i\right) = \delta_i + \sum_{k=5}^{VIL} \beta_1 VIL_{k,i} + \sum_{k=5}^{VIL} \beta_2 PT_i + \sum_{k=5}^{VIL} \beta_3 \left(VIL_{k,i} \times PT_i\right) + \beta_4 X_i + W\left(VIL_{k,i} + PT_i + X_i\right)\gamma + \mu_i \\ &\mu_i = \lambda W \mu_i + \varepsilon_i \end{aligned} , \qquad [7]$$

where, again, all variables and coefficients as well as W and μ_i are the same as the ones defined in eqs. [5] and [6]. The spatial dependence in the explanatory variables ($VIL_{k,i}$, PT_i, and X_i) is denoted by γ.

V. RESULTS

DID estimations

Table 8 presents the results obtained from the three models. The values of the adjusted R^2 and the Akaike Information Criterion (AIC) are provided at the bottom of the table. The log-likelihood and likelihood ratio are documented for the SAC/SARAR and SDEM in order to indicate the model fit and the significance of the spatial parameters included. Furthermore, the spatial autocorrelation is indicated by Moran's *I* of the estimated residuals and by the Lagrange Multiplier error test for spatial error dependence.

Overall, all three models perform well according to the values obtained for the adjusted R^2 and the AIC. Both indicators report the SDEM to have the highest explanatory power, while the spatial fixed effects model has the lowest. Given the two indicators for the presence of spatial autocorrelation (Moran's *I* and the LM error test), the spatial fixed effects model still suffers from spatial dependence despite the incorporation of city district effects. Both indicators obtain significant values at the 1% level, revealing strong spatial dependence in the error term and the residuals and, therefore, the inability of the spatial fixed effects model to control for spatial dependence. Furthermore, the SAC/SARAR and the SDEM substantially reduce and capture spatial dependence, with the tightest controls in case of the SDEM. In addition, the SDEM outperforms the SAC/SARAR in both the log-likelihood and the likelihood ratio test.

Table 8: DID estimates for the three model specifications

Variable	Spatial Fixed Effects Model Coef.	(SE)	SAC/SARAR / SE Model Coef.	(SE)	SDEM† Coef.	(SE)
Visual Impact Levels relative to *VIL I* (β_1)						
VIL VI	.025	(.040)	.088	(.046)	.107**	(.047)
VIL V	.052*	(.028)	.085***	(.033)	.095***	(.033)
VIL IV	-.005	(.026)	.026	(.028)	.039	(.028)
VIL III	-.006	(.023)	-.010	(.023)	-.000	(.023)
VIL II	.004	(.027)	-.045	(.029)	-.038	(.029)
Time differences relative to *BT* (β_2)						
PT	-.040	(.047)	-.001	(.046)	-.001	(.046)
DID estimates (β_3)						
*VIL VI * PT*	-.068	(.050)	-.094*	(.049)	-.108**	(.048)
*VIL V * PT*	-.128***	(.038)	-.099**	(.037)	-.100***	(.038)
*VIL IV * PT*	-.054	(.038)	-.034	(.037)	-.037	(.037)
*VIL III * PT*	-.012	(.034)	-.007	(.033)	-.008	(.033)
*VIL II * PT*	.108**	(.046)	.081	(.046)	.073	(.046)
Other explanatory variables (β_4)						
ln *Parcel size*	1.036***	(.010)	1.038***	(.010)	1.040***	(.010)
Waterfront	-.004	(.086)	.035	(.084)	.038	(.084)
Type single-family house	.143***	(.018)	.153***	(.018)	.151***	(.018)
Type duplex house	.204***	(.022)	.208***	(.021)	.205***	(.021)
Type row house	.155***	(.042)	.166***	(.040)	.151***	(.041)
Type multi-family house	.161***	(.038)	.154***	(.036)	.169***	(.036)
ln *CBD*	.068***	(.009)	.035***	(.011)	.022*	(.012)
ln *Supermarket*	-.004	(.014)	-.012	(.019)	-.042*	(.022)
ln *Commercial area*	.012	(.010)	.006	(.012)	-.010	(.014)
ln *School*	.035***	(.009)	.035***	(.011)	.030**	(.012)
ln *Forestland*	-.011	(.008)	-.040***	(.010)	-.056***	(.011)
ln *Major road*	-.014*	(.009)	-.010	(.010)	-.012	(.011)
ln *Road*	.058***	(.015)	.065***	(.014)	.064***	(.014)
Street noise	-.002	(.011)	-.006	(.015)	-.002	(.016)
ln *Railroads*	-.001	(.010)	.023	(.014)	.023	(.018)
ln *Transmission line*	-.044***	(.010)	-.101***	(.021)	-.156***	(.030)
ln *Lake*	.001	(.011)	.007	(.019)	.020	(.023)
(*Intercept*)	4.019***	(.199)	3.273***	(.270)	5.143***	(.782)
ρ (dependent variable spatial lag)			.055	(.075)		
λ (spatial error)			.834***	(.030)	.588***	(.057)
Adjusted R^2	.867		.877		.881	
AIC	274.22		163.8		132.8	
Log-likelihood			-21.59		16.62	
Likelihood ratio (LR) test			251.45***		53.13***	
Lagrange multiplier (LM) error test	267.57***		1.324		0.947	
Residuals Moran's *I*	16.15***		1.287*		1.107	

*, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

† Note: The SDEM estimates for the spatial lags in the explanatory variables are provided in Table A1 in the Appendix.

In the SAC/SARAR, the parameter for spatial dependence in the dependent variables ρ is found to be statistically insignificant, while the parameter for spatial dependence in the error term λ is significant. Thus, the SAC/SARAR can be reduced to a Spatial Error model. In our case, this implies that spatial dependence is not present in the form of spatially clustered spillover effects across neighboring properties, but rather in the form of spatial interdependencies among unobserved or poorly observed attributes. Hence, the applied SDEM is based on the spatial dependence-robust Spatial Error model and is further expanded by spatial lags in the explanatory variables (SDM). This outcome can be explained by the characteristics of SDMs in the presence of spatially dependent omitted local effects (Lerbs and Oberst, 2014). The estimated spatial lags for the various explanatory variables of the SDEM are provided in a separate Table A1 in the Appendix.

Across all models, the coefficient estimates can be directly interpreted as the impacts on property prices due to variations in the given attributes. Also in the case of the SDEM, the β coefficients obtained represent direct effects, whereas the coefficients for the spatially lagged explanatory variables correspond to cumulative indirect effects (LeSage and Pace, 2009).[13] Note that estimates for spatial lags of the explanatory variables (provided in Table A1 in the Appendix) usually tend to be higher in their magnitude, as they indicate the cumulative indirect effect of a variation in the given explanatory variable.

Given the comparison of the three models in terms of performance as well as shortcomings, the estimates obtained from the SDEM can be considered to be the most reliable ones. Therefore, the following discussion focusses on the SDEM estimates.

The first set of estimates in Table 8 presents the differences in property values across the various *VIL* relative to *VIL I*. Without considering the construction dates of the wind farms, the estimates indicate if there are any pre-existing differences among the *VIL* groups. Only *VIL VI* and *VIL V* obtain significant coefficients (.107 and .095, respectively), thus indicating a positive premium for these locations (*ex-ante* the 'wind farm treatment'). These locations were close to, and with an unobstructed view on, the eventual site of the wind turbines. As we only consider residential land within or near urban areas, the common assumption that wind farms are necessarily located near land plots of lower values does not hold for our study area in Germany.

The estimates for β_2 denote the differences in property values of time period *PT* (post-treatment) relative to the period *BT* (before treatment). According to the estimates obtained, no statistical evidence for a significant effect could be found, to some extent also due to the application of temporal fixed effects that enable controlling for annual and monthly variations.

The next set of coefficients, the DID estimates corresponding to β_3, are the key estimates of this analysis, as they measure the impact of the different *VIL* after the wind farms were constructed (*PT*) relative to the control group (properties without view on the constructed wind turbines). Most importantly, negatively significant impacts are found for properties that were

[13] For instance, the inclusion of a spatial lag in the dependent variables would have been more complicated regarding the direct comparison of the coefficients estimated, as in this case the dependent variable are not only directly affected by the locations' own characteristics, but also indirectly by neighboring locations (Lerbs and Oberst, 2014). For further information on parameter interpretation in spatial models, see LeSage and Pace (2009).

rated having an extreme (*VIL VI*) or dominant (*VIL V*) view of the wind farm *ex-post* construction. Properties with an extreme view on a wind farm site show a decrease in value of 10.8% (at the 5% significance level), and properties that obtained a dominant view dropped in value about 10% (at the 1% significance level). Overall, about 22% of the properties that were affected by the construction of the wind farm experienced property devaluation. These were mainly in close proximity to and with an unobstructed view on wind farms (*VIL* coefficients range between 0.6 - 1, see Table 5 and Figure 1). However, the small number of transactions (63) that occurred in the *VIL VI* group *ex-post* the turbines' construction limits the confidence that can be ascribed to the estimates obtained for this group. Nevertheless, negative impacts on property values for those properties with dominant views are consistent across all three estimated models. In contrast, medium (*VIL IV*) to marginal (*VIL II*) visual impacts are not found to have any significant impact on property prices. In general, according to the coefficients estimated for the different *VILs*, the magnitude of the negative estimates drops as the visual impact decreases.

The set of the remaining explanatory variables shows consistent estimates with respect to their respective coefficient signs and significance levels. Most prominently, as expected, the parcel size and the development statues affect property values positively. Furthermore, short distances to schools, the central business district (CBD), and the road network also have a positive influence on property values. Those distance measure can basically be interpreted as indicators for accessibility and centrality. *Vice versa*, the negative estimate for distance to the next forestland can be interpreted as an indicator for less centrality and remoteness, which is possibly viewed negatively and, ultimately, overcast potential amenity effects due to the proximity to natural reserve area.

One further interesting finding refers to the significantly negative impact of the proximity to electricity transmission lines. A decrease in the distance to the power lines by 1% results in a decrease of property values by .156%. Also here, the significantly negative impact is found to be consistent across all models. The power lines are ramified within the study area and connect the different wind farms with the urban areas, implying a close proximity to the properties in most parts of the area. Due to the widespread, and in rural and semi-urban areas even extensive, siting of energy infrastructure, it might be conceivable that transmission lines affect property values even more than wind farms. Because of their locational coherence, a joint assessment of the (visual) impacts of energy infrastructure (such as wind farms plus associated electricity grid) could be of interest for future research.

Placebo model

In order to test the robustness of the DID framework and the estimates obtained, we performed a series of placebo models on subsets of the dataset. A placebo model basically introduces a placebo treatment that does not exactly correspond to the actual treatment used in the original model, thus performing a procedure that is similar to a sensitivity analysis, which investigates a model's reliability through the variation of some of its key parameters.

Applied to our study case, we included in the placebo group only those properties that were sold before the wind farm construction. In turn, the data used in the placebo setting is reduced to 1,236 property sales taking place in the period between 1992 and 2001. During this time frame no wind farms were constructed in the study area. Apart from that, the treatment group and the control group are based on the same criteria presented. As there were no wind farms constructed in this period of time, the timing of the introduction of the treatment is chosen randomly. We perform different model settings, each assuming a hypothetical introduction of the treatment (wind farm construction) in the years between 1994 and 1999. To verify the robustness of the proposed initial framework, no significant wind farm impact should be measured, as the introduced placebo treatments are chosen arbitrarily.

A representative overview of the placebo estimates for the treatment year 1995 is provided in Table A2 in the Appendix. As the SDEM model yields the most reliable estimates in the DID setting described above, we conducted our analysis in the placebo settings only with the SDEM. Overall, the tested model settings consistently do not find any significant property value changes due to the placebo treatment. Therefore, arbitrarily chosen wind farm construction dates do not have any explanatory power on the variation of the property values. The remaining explanatory variables produced similar results to the ones obtained with the initial DID setting, where the set of structural variables (parcel size and development status) were found to explain most of the variation in property prices. The various distance measures (distance to road network, forestland, and schools) also had a similar influence on properties in the subset regarding their coefficient signs and significance values.

In summary, the series of placebo model settings underline the reliability and statistical evidence of the results obtained. In turn, this supports the application of the suggested DID framework as well as the proxies used for visual wind farm effects.

VI. Conclusions

We applied a spatial DID approach to investigate the local impacts of wind farms on the development of property prices in the surroundings of a semi-urban region in Germany. In the proposed DID framework, we compared price changes in a treatment group that included properties whose view was affected by the construction of a wind farm, with changes in a control group that consists of properties whose view remained unaltered. The level of the visual impact was assessed by means of a quantitative factor-based approach that incorporated the magnitude of visibility changes for each single property (in terms of the number of visible turbines), its distance to the nearest turbine, the view angle from the given property, as well as an overall visibility effect for the different city districts where each property is located. In addition, three alternative spatial models with different underlying spatial processes were estimated.

Our results indicate that the properties that obtained an extreme or dominant view due to the wind farm construction showed a decrease in price by about 10%. In contrast, medium to marginal changes in the propertiy’s views do not cause any statistically measurable adverse effect on its value.

In order to sufficiently capture visual effects caused by wind farms, the definition of valid and reliable proxies is one of the main challenges for this kind of hedonic pricing applications. Applying simple distance variables as proxies for local wind farm impacts can only provide a crude measure and should only be used as a first approximation. The same applies to binary visibility variables that only indicate if the wind farm site is visible or not. Furthermore, due to the subjective and somehow arbitrary nature of qualitative visual impact rankings, the incorporation of quantitative assessments is the preferable strategy. To date, literature that provides quantitative visual impact assessments is still sparse. In addition, most of the proposed methodologies are hard (or even not possible) to implement in hedonic pricing contexts. The approach suggested, and the incorporation of the visual impact assessment (proposed by Hurtado et al., 2004) definitely obtains potential for improvement and extension.

Regarding the estimated models, we find evidence for the application of spatial econometric methodologies that specifically address the problem of spatial dependence in property market data. In our case, the most commonly applied spatial fixed effects specification appears to be less suited due to its inability to capture spatial autocorrelation. Therefore, the application of spatial econometric models, such as the SDEM, is vital for preventing biases caused by the presence of spatial dependence and unobserved spatially clustered effects.

Finally, a further interesting and not yet fully explored potential application for this kind of analyses is the investigation of joint impacts of energy generation facilities and the associated energy infrastructure. In particular, transmission lines (i.e. overhead power cables) are widely spread across entire regions and involve a certain visual impact on the surrounding area. But, in contrast to wind farms, which constitute a large-scale element in the landscape that is limited to a specific location, transmission lines are continuous elements traversing entire landscapes. The investigation of those potentially joint, but yet characteristically different, impacts might yield valuable new insights and thus seems to be another fruitful avenue for future research.

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APPENDIX

TABLE A1: SDEM estimates for the spatial lag of the explanatory variables

Spatially lagged explanatory variables (γ)	Coeff.	(SE)
Spatial lag *VIL VI*	-.188*	(.108)
Spatial lag *VIL V*	-.021	(.091)
Spatial lag *VIL IV*	-.157*	(.092)
Spatial lag *VIL III*	.027	(.104)
Spatial lag *VIL II*	.408***	(.120)
Spatial lag *PT*	.148***	(.056)
Spatial lag ln *Parcel size*	.039	(.088)
Spatial lag *Waterfront*	-.789	(.748)
Spatial lag *Type single-family house*	.221**	(.110)
Spatial lag *Type duplex house*	.270*	(.146)
Spatial lag *Type row house*	-.686**	(.283)
Spatial lag *Type multi-family house*	.842**	(.368)
Spatial lag ln *CBD*	.032	(.028)
Spatial lag ln *Supermarket*	.067	(.052)
Spatial lag ln *Commercial area*	.123***	(.025)
Spatial lag ln *School*	.073**	(.031)
Spatial lag ln *Forestland*	.151***	(.031)
Spatial lag ln *Major road*	-.003	(.038)
Spatial lag ln *Road*	-.058	(.144)
Spatial lag *Street noise*	-.052	(.039)
Spatial lag ln *Railroads*	.001	(.027)
Spatial lag ln *Transmission line*	.138***	(.044)
Spatial lag ln *Lake*	-.053	(.038)

*, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

TABLE A2: SDEM results for the placebo model setting with the introduction of the treatment in 1995

Variable	SDEM† Coef.	(SE)
Visual Impact Levels relative to *VIL I* (β_1)		
VIL VI	-.029	(.071)
VIL V	-.086	(.053)
VIL IV	-.064	(.046)
VIL III	-.057	(.038)
VIL II	-.021	(.046)
Time differences relative to *BT* (β_2)		
PT (1995 – 2001)	.591***	(.047)
DID estimates (β_3)		
*VIL VI * PT*	-.078	(.078)
*VIL V * PT*	-.013	(.050)
*VIL IV * PT*	-.031	(.051)
*VIL III * PT*	.031	(.046)
*VIL II * PT*	-.041	(.052)
Other explanatory variables (β_4)		
ln *Parcel size*	1.044***	(.012)
Waterfront	-.257*	(.129)
Type single-family house	.313***	(.027)
Type duplex house	.361***	(.030)
Type row house	.312***	(.046)
Type multi-family house	.332***	(.046)
ln *CBD*	.009	(.015)
ln *Supermarket*	.002	(.022)
ln *Commercial area*	.006	(.018)
ln *School*	.025*	(.013)
ln *Forestland*	-.034**	(.014)
ln *Major road*	-.018	(.012)
ln *Road*	.051***	(.019)
Street noise	.014	(.018)
ln *Railroads*	.028	(.017)
ln *Transmission line*	-.027	(.028)
ln *Lake*	.053	(.024)
(*Intercept*)	3.859***	(.531)
λ (spatial error)	-.908***	(.253)
Adjusted R^2	.913	
AIC	45.82	
Log-likelihood	53.67	
Likelihood ratio (LR) test	11.17***	
Lagrange multiplier (LM) error test	.180	
Residuals Moran's *I*	-.276	

*, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

† Note: The SDEM estimates for the spatial lags in the explanatory variables are not provided in this table.

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BY KYLE GILLIS | TUESDAY, APRIL 2, 2013 | 6 COMMENTS

(An engineer's rendering of a proposed turbine in Searchlight)

SEARCHLIGHT — Ellen Ross, a Las Vegas-based real estate agent, bought her 17-acre property in Searchlight nine years ago as a reprieve from Vegas noise and for the property's long vistas of Joshua trees and the Newberry Mountains.

Her days of enjoying that uncluttered natural view became numbered, however, on March 13. That's when she learned she'll be getting new neighbors: a dozen 428-feet-tall wind turbines — each taller than the length of an American football field.

U.S. Secretary of the Interior Ken Salazar approved the turbines. They'll not only ruin her view, says Ross, but, more importantly, they'll significantly reduce the value of her property.

"I've been in the real estate industry for over 30 years," said Ross. "Who is going to want to buy property next to these giant turbines?"

Michele Shafe, the Clark County Assessor, told *Nevada Journal* she couldn't speculate on how much the wind turbines would affect Searchlight property values, because wind turbines "are relatively new" to Clark County.

However, recent studies and testimony by real estate appraisers from around the world indicate that properties within two to three miles of wind turbines have seen their values decline from 25 to 60 percent — with the decreased value being "tantamount to an inverse condemnation, or regulatory taking of private property rights."

One recent case study was conducted by Ben Lansink, a real estate appraiser based in Ontario, Canada. His study focused on the 133-turbine Melanchthon Wind Facility, 67 miles from Toronto — nearly the same distance as Searchlight is to Las Vegas.

Lansink reported that homes within two miles of the wind turbines sold for an average of 38 percent less than homes further away from the turbines. Some homes within the turbines' two-mile "footprint" sold for as little as 58.5 percent less.

"Certainly not every home within two miles of a turbine is affected," said Lansink. "But as we to endorse state-based religious discrimination

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learn more and more about turbines, there's a growing understanding that turbines do cause diminution of property. The question becomes: How much?"

The Searchlight Wind Energy, LLC Project — owned and operated by North Carolina-based Duke Energy — will consist of 87 turbines sitting on 9,300 acres of federal land. The project originally called for 161 turbines, according to Greg Helseth, a renewable-energy project manager at the Southern Nevada Bureau of Land Management, but the amount was reduced due to "the changing market of large-scale wind projects."

"Five years ago, there was a larger appetite for this type of project," said Helseth. "The applicant [Duke Energy] pared it down with the changing demand."

All 87 of the turbines are now planned for the east side of Searchlight. The original plans called for turbines to be located on both sides of US 95, the main highway that divides the town.

"Lots of [Searchlight residents] don't want this project," said Judy Bundorf, whose home will be 1.2 miles from the turbines.

"People live here, retire here, vacation here because of the natural beauty. They don't want to wake up every day and see 400-foot tall turbines sticking out of the desert."

Despite the reduction in the number of proposed turbines, it only takes one turbine to create a "bona-fide nuisance," according to Michael McCann, a Chicago-based real estate appraiser.

"Residential properties are more sensitive to undesirable locations," said McCann. "One mile may seem like a long distance away, but it doesn't take much for the property to experience a diminution effect."

McCann has evaluated or consulted on more than 20 wind projects in 12 states, and has published his own case studies showing turbines' impacts on property value. In a 2012 study he conducted on Van Wert County, Ohio, McCann says he discovered that homes within the turbine's two-to-three mile "footprint" sold for 26 percent less than homes six miles away from the turbines.

Van Wert County, Ohio 2012 Residential Sale Summary

Township	# Sales	# Sales via Foreclosure	% via foreclosure	Avg. Price*	Avg. $/Sq Ft*	Setting
York & Liberty	11	1	9%	$78,980	$41.08	6 miles away
Union & Hoaglin	15	7	47%	$58,417	$31.97	Footprint
Difference	+ 4	+ 6	+38%	($20,563)	($9.11)	
% Difference				(26%)	(22%)	

*Excluding related party – Family sales

Chart courtesy of Michael McCann, 2012.

McCann's most recent case study, a March 2013 evaluation of a proposed wind farm in Tipton County, Ind., concluded that homes nearest to the proposed turbines could see at least a 25 percent loss in value, and that the 1,250-foot turbine-to-property setback proposed by the turbine company was inadequate.

For its Searchlight Final Environmental Impact Statement (FEIS) project, the BLM cited 10 different studies of wind projects' impact on property values. The agency concluded that "no clear inference can be drawn from these studies," and that the varying research methodologies suggest that "there is no negative relationship between wind energy developments and property values."

"We [BLM] listened to the public comment and included all of our recommendations in the final statement," said Helseth.

The studies BLM referenced ranged from a 1996 study conducted by The Institute of Local Government Studies in Copenhagen, Denmark, to a 2009 study by the Department of Energy-funded Lawrence Berkeley National Laboratory in Berkeley, Calif.

While most of the studies were conducted by academics or prepared on behalf of wind companies, McCann and Lansink are each 30-year veterans of the appraisal industry.

“I wasn’t paid. I didn’t do [the study] for the wind industry or for the people affected by them,” Lansink said.

McCann’s Tipton County study lists four categories of “nuisance” issues related to turbines: Noise, Visual, Safety, and Essential Character — meaning the turbine changes the nature of the landscape.

All four issues could affect Searchlight residents, but the two issues residents are most concerned about are the noise and visual, says Bundorf. Representatives from the BLM and Duke Energy told residents at a public meeting during the planning phase that the turbines wouldn’t sound any louder than a “refrigerator humming.”

However, a 2010 assessment of wind turbine noise published by Rand Acoustic, a Maine-based acoustic consulting company that specializes in environmental noise control, concluded that: “Wind turbines larger than one megawatt of rated power have become an unexpected surprise for many nearby residents by being much louder than expected.”

Said the assessment: “Wind turbines are not synchronized, and so thumps may arrive together or separately, creating an unpredictable or chaotic acoustic pattern. The sounds of large industrial wind turbines have been documented as clearly audible for miles. They are intrusive sounds that are uncharacteristic of a natural soundscape.”

On YouTube, homeowners around the country have sought to share their experience of nearby power windmills. An example is the report of this Wisconsin homeowner, who says he lives only 1,600 feet from a turbine.

Several appraisers, including McCann, compare living next to a wind turbine to living next to an airport.

“Imagine living very close to a large airport, and a plane passing between you and the sun, and the giant shadow it casts on you for a moment,” McCann said. “Now, imagine that this happened every sunny morning, 30 times per minute, for an hour and a half, and then the next day, and next day.”

The turbines will line the desert landscape stretching toward Cottonwood Cove near the Lake Mead Recreational Area. Bundorf’s brother-in-law, a retired engineer, used the BLM and Duke Energy proposals to create a photo rendering of what the turbines will look like from Ross’ neighbor’s property. Ross’ and her neighbor’s properties are just over 1,000 feet away from the proposed turbines. The photo graphic suggests the view they formerly enjoyed will be drastically changed.

(Image courtesy of Wayne Bundorf)

“This is pristine desert property,” Ross said. “Most of us bought property out here for the peace and quiet and unobstructed views. This [wind farm] changes everything about our [property] value.”

McCann’s study also raises the issues of the safety of crop-dusting pilots flying low over farms where wind turbines operate, and of the “Essential Character” of areas changing because of the “industrial overlay” of the turbine machinery.

Many Searchlight residents, including Sandy Walters, chairwoman of the Searchlight Town Advisory Board, believe animal safety is a concern, too, especially in the wake of the Spring Valley Wind Farm in White Pine County reporting the death of its first golden eagle.

"[Dead birds are] not something we want to be known for," said Walters. "Tourists drive here from other states to see the scenery, and they're driving to get away from things like wind farms."

As part of its FEIS, BLM provided a Bird and Bat Conservation Strategy report that concluded no bald nor golden eagles were within the project's area. The federal land agency has also provided a similar report for the White Pine County wind farm, citing national wind experts who "estimated that 2.3 avian fatalities per turbine per year (3.1 per megawatt per year) occur in the United States."

A spokeswoman for the White Pine County assessor's office told *Nevada Journal* that White Pine's Spring Valley Wind farm hadn't been operational long enough to determine its impact on property values.

Diane Kendall, a member of the Searchlight Advisory Board and a real estate agent, supports the wind project and thinks if it was able to pass all of the BLM's regulations, then it should be good for the town.

"Everything a human does has impact on the land," said Kendall. "BLM has some of the strictest regulations around, so if it passed them, then I think we should go for it."

Helseth told *Nevada Journal* the project is still at least two to three years away from officially breaking ground. For residents like Ross, that means they have a few years left to enjoy their view.

"The good doesn't outweigh the bad," said Ross.

"If I brought someone out here to look at property with a view of the mountains or a property with a view of wind turbines, which one do you think they'll buy?"

Kyle Gillis is a reporter for Nevada Journal, a publication of the Nevada Policy Research Institute. For more in-depth reporting, visit http://nevadajournal.com/ and http://npri.org/.

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Local Cost for Global Benefit: The Case of Wind Turbines

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and Colin Vance[1]

Local Cost for Global Benefit: The Case of Wind Turbines

Abstract

Given the rapid expansion of wind power capacities in Germany, this paper estimates the effects of wind turbines on house prices using real estate price data from Germany's leading online broker. Employing a hedonic price model whose specification is informed by machine learning techniques, our methodological approach provides insights into the sources of heterogeneity in treatment effects. We estimate an average treatment effect (ATE) of up to -7.1% for houses within a one-kilometer radius of a wind turbine, an effect that fades to zero at a distance of 8 to 9 km. Old houses and those in rural areas are affected the most, while home prices in urban areas are hardly affected. These results highlight that substantial local externalities are associated with wind power plants.

JEL Classification: IQ21, D12, R31

Keywords: Wind power; hedonic price model

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1 Manuel Frondel, RWI and RUB; Gerhard Kussel, RWI and RUB; Stephan Sommer, RWI; Colin Vance, RWI and Jacobs University, Bremen. *– This work has been supported by the Collaborative Research Center "Statistical Modeling of Nonlinear Dynamic Processes" (SFB 823) of the German Research Foundation (DFG), within Project A3, "Dynamic Technology Modeling". We also gratefully acknowledge financial support by the German Federal Ministry of Education and Research (BMBF) within Kopernikus Project ENavi (grant 3SFK4B0) and Project DIPOL (grant 01LA1809C).* *– All correspondence to: Gerhard Kussel, RWI, Hohenzollernstraße 1/3, 45128 Essen, Germany, e-mail: gerhard.kussel@rwi-essen.de*

1 Introduction

Germany is widely seen as a global leader in efforts to mitigate climate change, having implemented an extensive feed-in-tariff scheme for renewable energy technologies whose aim is to contribute to the reduction of greenhouse gas (GHG) emissions by 40% in 2020 relative to 1990. Wind power is among the most promising renewable energy technologies, as it has a high generation potential with comparatively low costs. Between 2000, when feed-in-tariffs were introduced under Germany's Renewable Energy Act, and 2017, the number of onshore wind turbines roughly tripled, increasing from 9,359 to 28,675. Over the same interval, electricity generation from wind power increased from 9.5 to 106.6 billion kilowatthours, corresponding to a share of 18.8% of Germany's net electricity generation in 2017 (Data source: WindGuard).

Notwithstanding a broad-based popular acceptance of wind power, companies planning new wind turbines frequently meet massive resistance of local communities owing to negative externalities. In addition to posing hazards for birds and bats, the turbines make noise and affect the aesthetic appeal of the landscape by adding movement in the form of rotation and shadow flickers, leaving a more industrialized and less tranquil impression. Ultimately, such impacts may bear negatively on house prices. Yet, while there is some international evidence on the effect of nearby wind turbines on real estate prices, empirical evidence for Germany is scant.

Various methods can be availed for valuing external environmental costs, including stated-preference surveys, as well as by investigating revealed preferences as expressed via real estate prices. We add to the latter strand of the literature by analyzing the impact of wind turbines on the price of single-family houses. Drawing on a data set of asking prices from more than 2.7 million houses in Germany posted between 2007 and 2015 on the site of Germany's leading online broker, our approach employs a hedonic pricing model whose specification is informed by the causal forest machine leaning algorithm (**?**) to identify sources of heterogeneity.

We find an average treatment effect (ATE) of up to -7.1% for houses within a one-kilometer radius of a wind turbine, an effect that fades to zero at a distance between 8 and 9 km. As suggested by the causal forest algorithm, additional specifications are estimated that allow for differential effects of the wind turbines by the house's location and age. We find that very old houses and houses in rural areas suffer price reductions of up to 23%, probably due to stronger preferences for a pristine landscape, while house prices in urban areas are not affected at all. Our results illustrate that while electricity generation via wind turbines may have global benefits, these are accompanied by substantial local externalities.

The subsequent section provides a brief review of the literature on the effect of wind turbines on real estate prices. Section 3 concisely summarizes our database, followed by the description of our methodology in Section 4. We present and discuss our results in Section 5. The last section closes with a summary and conclusions.

2 Findings from the Literature

Growing global energy demand and the increased awareness of anthropogenic climate change have led to an increase in wind power capacities worldwide. The rising number of wind turbines, however, draws increasing attention to their negative externalities. Wind turbines not only endanger animals in their natural environment, notably birds and bats (Arnett et al., 2008; Barclay et al., 2007; Smallwood, 2007), but also make noise, create flicker effects, and negatively impact the scenery. Numerous stated-preference surveys suggest that people have a positive attitude towards wind power in general, but, at the same time, are concerned about external effects and environmental costs (Krekel and Zerrahn, 2017; Brennan and Van Rensburg, 2016; Meyerhoff et al., 2010; Swofford and Slattery, 2010).

Such surveys, however, may be subject to measurement error, particularly when respondents do not wish to state their true preferences. An alternative approach is to make use of peoples' revealed preferences, which are less prone to biases from strategic responses. Real estate prices consist of peoples' revealed willingness to pay for numerous housing, locality and environmental characteristics, leading to a hedonic house price model (Lancaster, 1966; Rosen, 1974). Adding the proximity to a wind turbine as a feature, peoples' valuation of corresponding externalities can be identified.

Following this basic idea, the effect of nearby wind turbines on housing prices has been analyzed in diverse settings, yielding mixed results. Lang et al. (2014), for instance, examine the impact of wind turbines on real estate prices in the U.S. state of Rhode Island. Employing a modified difference-in-difference approach, these authors find no effect of nearby wind turbines on real estate prices across model specifications. Similar results are obtained by Hoen et al. (2015), who model more than 50,000 real estate transactions from all over the U.S. by means of ordinary least squares and difference-in-difference estimation. Analyzing data from densely populated communities in the U.S. state of Massachusetts, the results of Hoen and Atkinson-Palombo (2016) also suggest that wind turbines have no effect on real estate prices. In contrast, employing a repeat sales fixed-effects approach, Heintzelman and Tuttle (2012) find a significantly negative effect in two of three analyzed municipalities in New York State.

While the empirical literature for the U.S. predominantly detects no effect of wind turbines on real estate prices, the available studies for European regions point to significantly negative impacts. Using a difference-in-difference methodology, Dröes and Koster (2016), for example, analyze Dutch house price data and estimate a small negative effect of -1.4% for wind turbines within a 2 km distance. With a similar approach for England and Wales, Gibbons (2015) finds a price reduction of up to 6% on houses having a wind turbine within 2 km, fading to zero at a distance of 8 to 14 km. Employing various estimators that distinguish separate effects of noise and visual pollution, Jensen et al. (2014) obtain an effect of similar size for Denmark. These authors attribute a 3% price reduction to visual disamenities and 3 to 7% to noise pollution, which only affects houses in immediate proximity to a turbine.

To the best of our knowledge, the only available evidence for Germany is provided by Sunak and Madlener (2015) and Sunak and Madlener (2016), who analyze the effect of wind turbines on real estate asking prices in a small semi-urban region. Using augmented spatial econometric models, Sunak and Madlener (2016) find a strong effect of -9 to -14% for the most affected houses. Providing the first comprehensive analysis for Germany as a whole, we add to this strand of the literature by offering insights into the sources of treatment effect heterogeneity.

3 Data

Our primary data source is drawn from ImmobilienScout24, Germany's leading online real estate platform. This data includes asking prices and building characteristics for more than 7 million residential units posted between 2007 and 2015. The focus of our analysis is on house sales, as the effect of amenities is presumably a less important factor for rental units. For the same reason, we exclude multi-family houses, instead solely focusing on single-family houses.

A potential drawback of the data is that the recorded prices are asking prices, rather than transaction prices. This would be problematic if the difference between asking and transaction prices is correlated with real estate or locality characteristics. Several recent studies using the ImmobilienScout24 data argue, however, that this concern is unfounded. These include an assessment of the effect of nuclear power plant shut downs on surrounding real estate prices by Bauer et al. (2017) and the analysis of the effect of national borders on house prices by Micheli et al. (2019). Frondel et al. (2019), who investigate the effect of mandatory disclosure of energy information in sales advertisements on German house prices, likewise explore this issue. They compare data on asking prices from ImmobilienScout24 with municipal data on transaction prices from Germany's capital Berlin, finding that (1) the difference between the two price series is moderate, with transaction prices being about 7% lower than asking prices, and that (2) this difference remains approximately constant over time.

While our sample consists of houses that were offered between 2007 and 2015, for estimation purposes, we pruned the data along several dimensions, excluding houses with (i) unusual prices below €20,000 or above €2,000,000, (ii) a reported living space of either less than 40 m^2 or more than 800 m^2, (iii) either less than 1 or more than 20 rooms and, (iv) a lot size smaller than 20 m^2 or larger than 5,000 m^2. As a result, our final data set comprises 2,855,466 observations.

The summary statistics reported in Table 1 indicate that the average asking price of the sample properties is about €274,000, the mean size is 154 m^2, and the mean number of rooms is 5.4. With about 55%, detached houses represent the majority of the sample properties, with another 17% of the properties being semidetached. With respect to the temporal dimension, the offers are almost equally split across the period 2007-2015.

Table 1: Descriptive Statistics of Real Estate Offers

	Mean	Standard Deviation	Minimum	Maximum
Asking price in €	273,786.4	203,136.9	20,000	2,000,000
Year of construction	1979.5	36.9	1300	2016
Living space in m^2	153.7	60.4	40	800
Lot size in m^2	676.4	536.3	20	5,000
Number of rooms	5.4	1.8	1	20
Detached house	0.55	-	0	1
Semidetached house	0.17	-	0	1
Other house type	0.08	-	0	1
Terrace house	0.04	-	0	1
Mid-terrace house	0.06	-	0	1
End-terrace house	0.04	-	0	1
Bungalow	0.03	-	0	1
Villa	0.03	-	0	1
Offer year 2007	0.08	-	0	1
Offer year 2008	0.15	-	0	1
Offer year 2009	0.13	-	0	1
Offer year 2010	0.12	-	0	1
Offer year 2011	0.11	-	0	1
Offer year 2012	0.09	-	0	1
Offer year 2013	0.11	-	0	1
Offer year 2014	0.11	-	0	1
Offer year 2015	0.10	-	0	1
Number of Observations:			2,855,466	

Separated descriptives for the treatment and control group are reported in Table A.1 in the appendix

In addition to the information on real estate characteristics, the data contains the exact coordinates of each house. This feature allows us to merge it with other georeferenced data sources, such as the database RWI-GEO-GRID (Breidenbach and Eilers, 2018), which provides high-resolution socio-demographic data on the scale of a 1x1 km grid. We make use of information on purchasing power per capita, population density, the unemployment rate, the share of foreigners, the number of buildings and demographic structure of the grid.[1]

To complete the locality characteristics, we add the distance to the center of the next city with more than 100,000 inhabitants and dummy variables for all German municipalities. Table 2 demonstrates substantial heterogeneity in the socio-demographic characteristics of the neighborhood. For instance, the purchasing power per capita ranges between €5,900 and €139,000. Moreover, we observe a large diversity in the population density, spanning as low as 1 inhabitant per km^2 in very rural areas to almost 27,000 inhabitants in highly urbanized areas.

Table 2: Descriptive Statistics of Locality Characteristics in 1x1 km Grids

	Mean	Standard Deviation	Minimum	Maximum
Purchasing power per capita (in €)	21,464.8	4,104.9	5,916.7	139,391.0
Total inhabitants per km^2	1,837.5	1,707.4	1.0	26,947.0
Unemployment rate (in %)	5.97	3.94	0.01	39.98
Foreigners (in %)	6.66	5.74	0.01	100.00
Number of buildings	434.8	306.2	1.0	2830.0
Share of inhabitants aged 0-20	19.52	2.66	0.18	38.67
Share of inhabitants aged 20-35	16.20	2.95	0.40	47.50
Share of inhabitants aged 35-45	14.44	2.16	0.35	42.22
Share of inhabitants aged 45-55	16.46	1.87	0.54	40.80
Share of inhabitants aged 55-65	12.70	1.86	0.27	35.44
Share of inhabitants aged 65+	20.68	1.86	3.17	97.96
Distance to city center (in km)	24.52	20.27	0.03	146.18
Distance to next wind turbine (in km)	8.43	6.28	0.02	54.83
Number of Observations:		2,855,466		

Separated descriptives for the treatment and control group are reported in Table A.1 in the appendix

Finally, we obtained geo-referenced data on wind turbines in Germany from the Re-

[1]The data is gathered by the commercial data provider *Micromarketing-Systeme und Consult GmbH (microm)* and is aggregated from more than one billion individual data points from various sources. Raw data are collected from companies acting in data intensive environments such as Creditreform and CEG Consumer Reporting, as well as from official institutions such as the Federal Office for Motor Traffic, the Statistical Offices of the Federation and the Federal States, and the Federal Employment Agency. Since RWI-GEO-GRID is only available for the years 2005 and 2009-2015, we interpolate the information for the years 2006-2008.

newable Energy Installations Core Data of the Federal Network Agency (BNetzA) and several regional authorities. The central register provided by BNetzA was introduced in August 2014. Hence, all information on the wind turbines that were installed after this date is retrieved from BnetzA, while all prior information is collected from federal state authorities. Both data sets are compatible and commonly encompass the construction year and the exact position of all wind turbines in Germany, but we dropped 2,373 observations due to missing information on the construction year.

At the beginning of our study period, 13,574 wind turbines were installed in 2007, mostly in the northeast owing to better wind conditions(Figure 1). This is the most propitious area for wind turbines, as average wind speeds are significantly higher compared to other regions in Germany. By the end of 2015, after stronger incentives in the form of higher feed-in tariffs for electricity produced from wind power were introduced, 7,883 wind turbines were additionally installed, also in less windy areas, such as the southeast of Germany.

While the mean distance of sample houses to the next wind turbine is about 8.4 km (Table 2) and the median amounts to 6.6 km, Figure 2 illustrates a great deal of heterogeneity: 8.9% of the properties have a wind turbine within a 2 km distance, whereas 0.6% are located more than 30 km away from a wind turbine.

Figure 1: Position of Wind Turbines

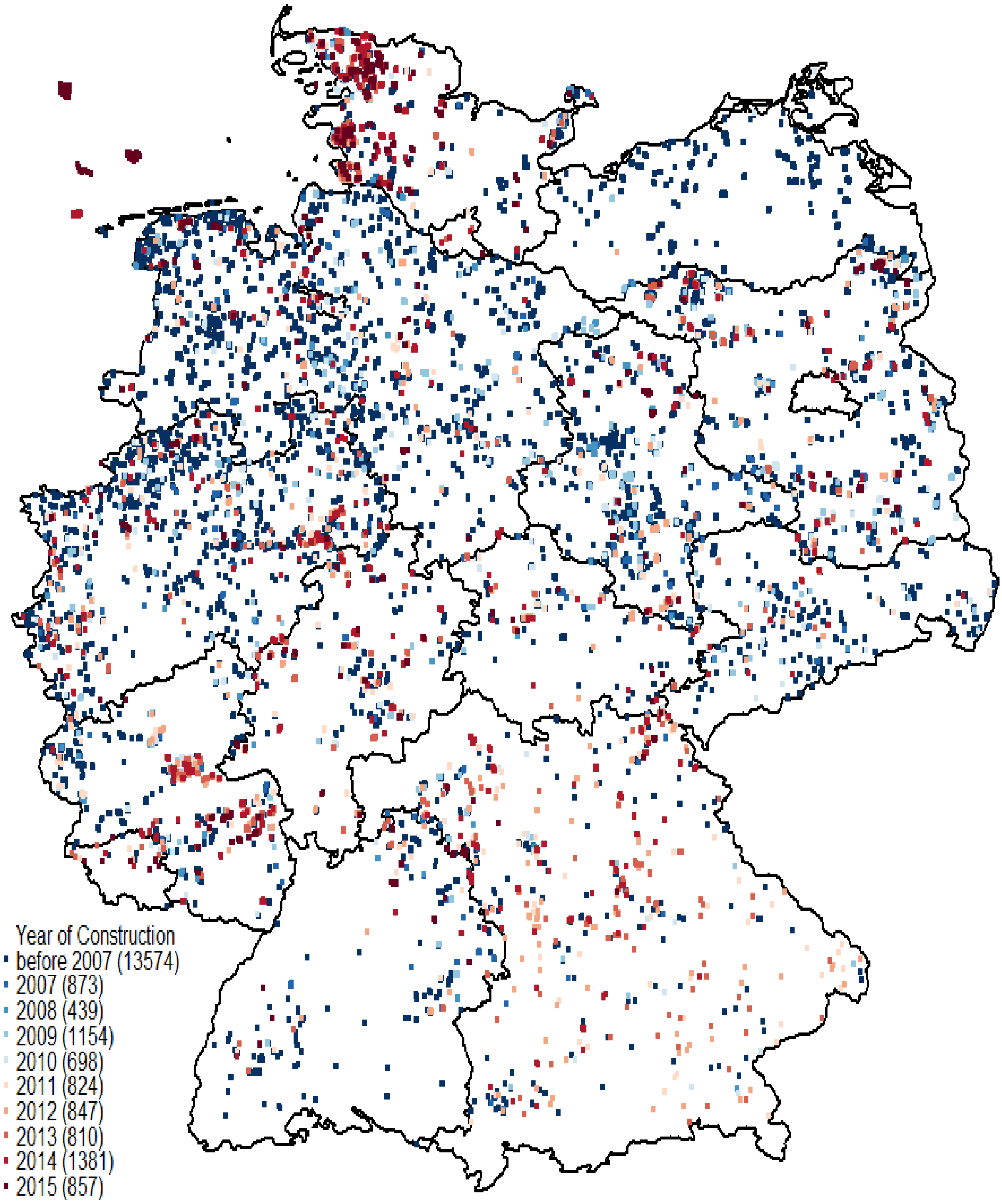
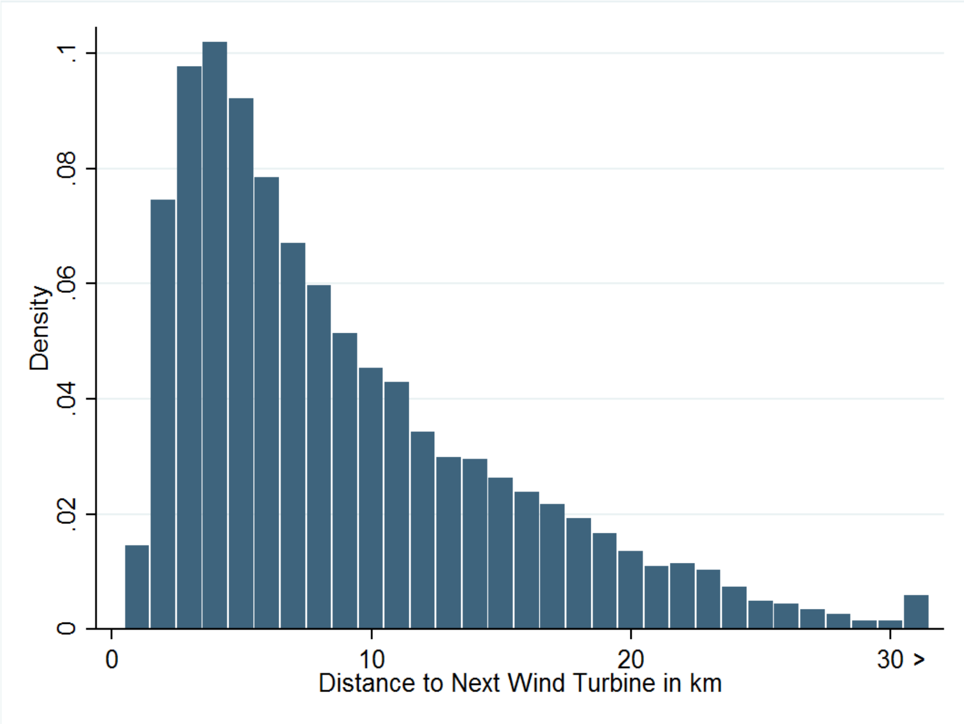


Figure 2: Distance to Wind Turbines



4 Methodology

To identify the impact of wind turbines on the prices of nearby houses, we estimate the following hedonic price model by Ordinary Least Squares (OLS):

$$\log(p_i) = distance_i^T\, \boldsymbol{\alpha} + \mathbf{x}_i^T \boldsymbol{\beta} + m_g + \tau_t + \varepsilon_i, \tag{1}$$

where $\log(p_i)$ is the natural logarithm of the asking price of house i and *distance* is a set of distance bands indicating whether the house is within the radius of 1, 2,...9 km distance to a wind turbine. $\mathbf{x}$ comprises house and locality characteristics, $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are corresponding coefficient vectors, m_g and τ_t are fixed-effects for municipality g and time t, and ε_i is an error term that is independent and identically distributed. Our main focus is on coefficient vector $\boldsymbol{\alpha}$, which measures the average treatment effect for houses within 1, 2,...9 km distance to a wind turbine.

As we observe the asking price for a property either in presence (Y_{i1}) or in absence (Y_{i0}) of a wind turbine, but not in both states, we face the well-known evaluation problem (Holland 1986). Following the idea of Rubin's (1974) potential-outcome model:

$$Y_i = \begin{cases} Y_{i0} \; if \; W_i = 0 \\ Y_{i1} \; if \; W_i = 1, \end{cases} \tag{2}$$

where W is a binary indicator that equals unity when house i is in the range of a wind turbine and zero otherwise, the average treatment effect (ATE) is given by $ATE := E\left(Y(1)|W = 1\right) - E\left(Y(0|W = 0)\right)$. Accordingly, if the assignment of the treatment W were to be randomized, a situation that is implausible in observational studies, the causal effect of the treatment can easily be estimated by a simple comparison of mean outcomes. Yet, in our empirical example, it seems likely that wind turbines are more frequently placed in less wealthy neighborhoods, as land prices are lower and residents have less resources to oppose construction. At the same time, house prices in those areas are probably lower as well.

To identify the causal effect of the treatment, we need to assume unconfoundedness, i.e. that all determinants affecting the probability of the treatment (having a wind turbine nearby) and the outcome (house price) are captured by our covariates (X):

$$W_i \perp (Y_{i0}, Y_{i1})|X. \tag{3}$$

While this assumption is critical, it is not testable. Nevertheless, below we provide a supplementary analysis to increase the credibility of our estimates that is a based on a placebo-regression approach.

A final estimation issue concerns the possible existence of interaction terms that capture differential magnitudes in the effects of wind turbines. In this regard, it is conceivable that the effect of proximity to a wind turbine is dependent on other features of the house and of the surrounding landscape. It stands to reason, for example, that houses located in densely settled areas would be affected differently by wind turbines than those surrounded by pristine landscapes.

While theory can provide some guidance in identifying such sources of heterogeneity, the attempt to specify a complete set of interactions risks embarking on an iterative search for results that are, even if statistically significant, purely spurious (Assmann et al., 2000; Cook et al., 2004). Building on work by Athey and Imbens (2016), Wager and Athey (2018) develop a nonparametric machine learning algorithm to address this challenge. In essence, their approach draws on asymptotic normality theory to enable statistical inference using a forest-based method to generate predictions that are asymptotically unbiased. The method, which we implement using an R package provided by the authors, is akin to an adaptive nearest neighbor method, producing estimates of the conditional average treatment effect. We employ the method as an exploratory tool, using it to identify sources of heterogeneity in the estimation of treatment effects that we incorporate in the specification of Equation 1.

5 Empirical Results

Table 3 presents OLS estimates from a specification of hedonic price model 1 that excludes treatment heterogeneity, while Figure 3 allows visualization of the corresponding estimates of each distance band and its confidence interval. The figure illustrates that the average treatment effects are statistically and economically significant for houses that are within a distance of up to 8 km to a wind turbine. Unsurprisingly, the strongest effect is found for houses in the smallest radius of a one-kilometer distance, where the presence of turbines reduces house prices by 7.1% ($= 100[exp(-0.0735) - 1]$). In addition to impairing the scenery, wind turbines in such close proximity create audible noise and flicker effects. Although the treatment effects abate with distance, they remain statistically significant up to a radius between 7 to 8 kilometers, where noise should be irrelevant (Gibbons, 2015).

The coefficients on the remaining covariates are all statistically significant and exhibit the expected signs, albeit the effect sizes are small in many cases. Given the

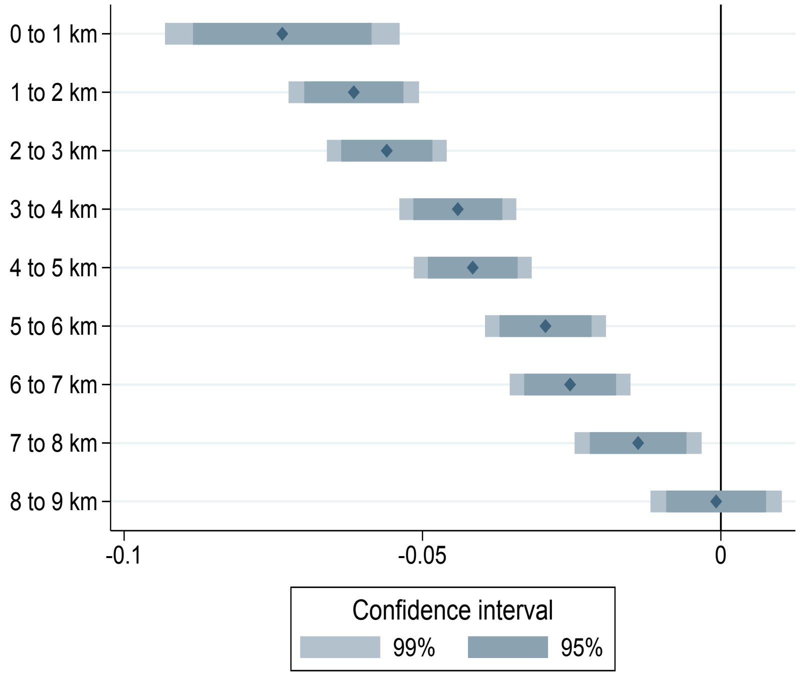
Table 3: OLS Regression Results of Equation 1

	Coefficients	Standard Errors
Wind turbine within		
1 km distance	-0.0735**	(0.00763)
1 to 2 km distance	-0.0615**	(0.00424)
2 to 3 km distance	-0.0560**	(0.00399)
3 to 4 km distance	-0.0441**	(0.00381)
4 to 5 km distance	-0.0416**	(0.00384)
5 to 6 km distance	-0.0294**	(0.00394)
6 to 7 km distance	-0.0253**	(0.00393)
7 to 8 km distance	-0.0139**	(0.00413)
8 to 9 km distance	-0.000786	(0.00427)
Housing characteristics:		
Year of construction	0.00453**	(0.0000479)
Living space (in m^2)	0.00410**	(0.0000298)
Lot size (in 100 m^2)	0.0122**	(0.00221)
Number of rooms	-0.0104**	(0.000801)
Detached house	0.0260**	(0.000993)
Semidetached house	-0.0601**	(0.000576)
Terrace house	-0.153**	(0.00114)
Mid-terrace house	-0.149**	(0.000895)
End-terrace house	-0.0838**	(0.00108)
Bungalow	0.0383**	(0.00114)
Villa	0.214**	(0.00122)
Locality characteristics:		
Purchasing power per capita (in 1,000 €)	0.0382**	(0.00106)
Total inhabitants (in 1,000)	0.031**	(0.00173)
Unemployment rate (in %)	-0.00452**	(0.0000849)
Foreigners (in %)	0.00407**	(0.000595)
Number of buildings	-0.00002*	(0.00000810)
Share of inhabitants aged 0-20	-0.0135**	(0.000905)
Share of inhabitants aged 20-35	0.00619**	(0.000594)
Share of inhabitants aged 35-45	0.00507**	(0.000981)
Share of inhabitants aged 45-55	-0.0148**	(0.000745)
Share of inhabitants aged 55-65	-0.0102**	(0.000824)
Distance to city center (in km)	-0.00420**	(0.000208)
Year dummies	Yes	
Municipality dummies	Yes	
Number of Observations:	2,855,466	
R^2	0.711	

Note: $**$ and $*$ indicate statistical significance at the 1% and 5% level,respectively; standard errors are clustered at the GEO-Grid level.

log-linear specification of the model, most of these estimates can be interpreted as the percentage change in the house price given a unit change in the explanatory variable. We see, for example, that each square meter increase in living space increases the house asking price by 0.4%, while each additional kilometer from the nearest city center decreases the price by about the same amount.

Figure 3: Effects of Wind Turbines on logged House Prices



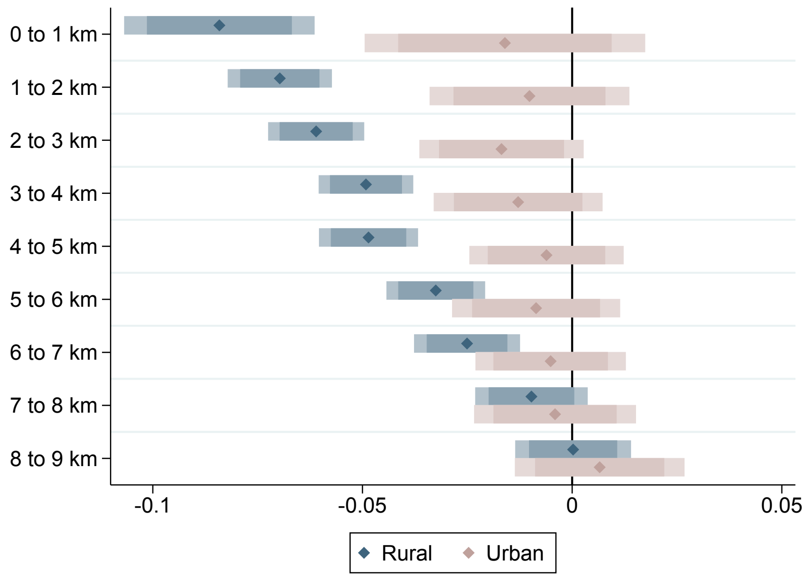
Note: Standard errors are clustered at the GEO-Grid level.

5.1 Heterogeneity in Treatment Effects

In principle, any of the control variables could be a source of heterogeneity in the treatment effects. To identify such sources, we plotted the results obtained from the causal forest algorithm applied to the covariates included in Equation 1. For this purpose, we collapsed the nine treatment dummies into a single dummy equaling unity if a wind turbine is within a distance of 8 kilometers of the home and zero otherwise. For the overwhelming majority of covariates, we find no significant mediating effect on the treatment dummy. Two exceptions are the distance to the next city center and the year of construction, both of which exacerbate the effect of proximity to a wind turbine. Specifically, as seen from Figures A4 and A5 in the appendix, there are rapid increases in the magnitude of the treatment effect for a distance to the next city center of more than 10 kilometers and construction years before 1950.

Based on these results, we construct an urban indicator that equals unity if the house offer is within a 10 km^2 radius around the next city center and zero otherwise, as well as an age indicator for houses that were built before 1950, and interact both indicators with the treatment dummies in Equation 1. Figure 4 illustrates the differences in the treatment effects between urban and rural areas. While there are substantial treatment effects in rural areas, the effect on prices of houses close to urban environments is considerably weaker and statistically insignificant at any conventional level.

Figure 4: Effects of Wind Turbines on logged House Prices in Rural and Urban Areas



Note: Standard errors are clustered at the GEO-Grid level. Coefficient estimates are reported in Table A.3 in the appendix.

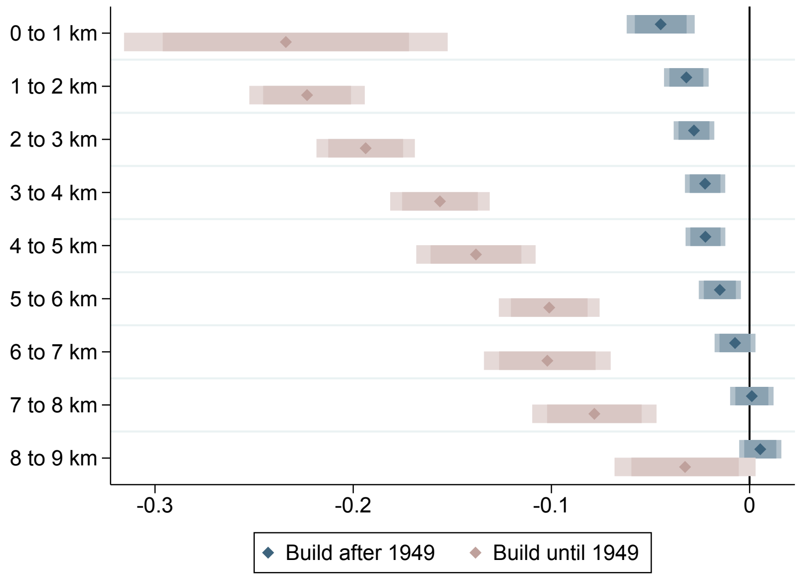
Contrasting with Dröes and Koster (2016), who find a stronger effect in urban environments, our finding seems intuitive given two potential explanations: First, to the extent that the urban landscape is already developed, the sight of a wind turbine might not change the overall impression of the landscape. Second, a more urban environment has a higher density of buildings that conceal the view of the wind turbine (Sunak and Madlener, 2015). This second explanation, however, does not apply to our data, as we control for the density of buildings. Hence, we conclude that the nativeness of the

[2] According to this definition 24,99% of the observations are located in urban areas. Results of robustness checks with alternative definitions (5 km, 9,19%; 20 km, 53,13%; and 50 km, 88,40%) are reported in the appendix (Figures A1 - A3).

landscape and the corresponding preferences of the residents seem to determine the effect size.

With respect to the age of buildings, Figure 5 shows a remarkable effect of up to -23% on the prices of houses built before 1950, whereas newer buildings are affected to a much lower extent. This effect may also be explained by preferences for a preindustrial impression of the building and the surrounding landscape.

Figure 5: Effects of a Wind Turbine on logged House Prices of Old Buildings and Newer Houses

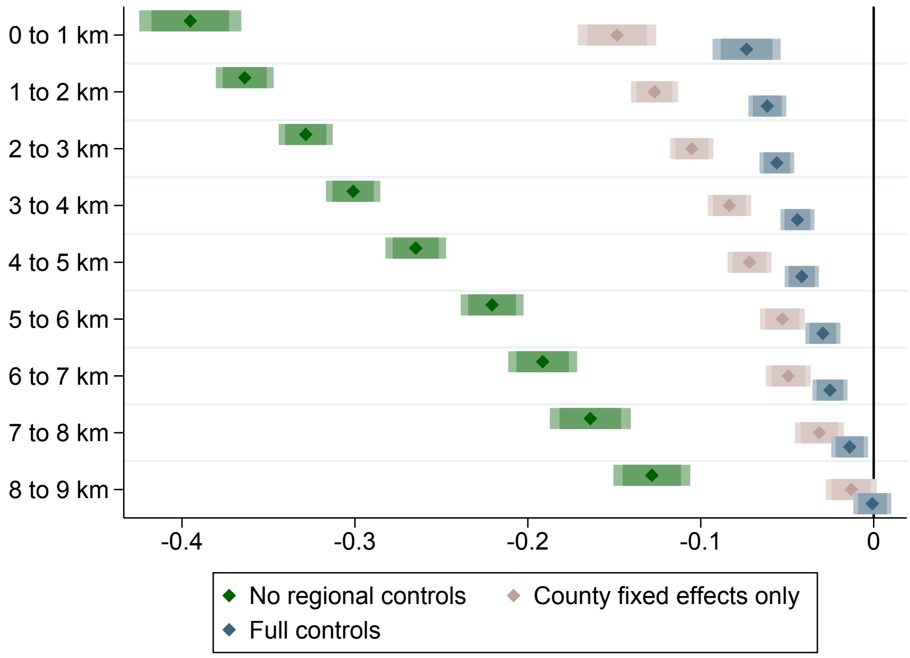


Note: Standard errors are clustered at the GEO-Grid level. Coefficient estimates are reported in Table A.4 in the appendix.

5.2 Unconfoundedness

As discussed in Section 4, our results can only be interpreted as causal if the unconfoundedness assumption holds, i.e. all determinants affecting the probability of the treatment – a nearby wind turbine – and the outcome – the house price – are captured by our covariates. To probe this assumption, we begin by estimating Equation 1 using three sets of control variables: First, Equation 1 is estimated without any local controls using only house characteristics and time fixed effects; second, we additionally include community fixed effects and, third, Equation 1 is estimated using all control variables. Figure 6 illustrates that the treatment effects shrink significantly when county fixed effects and the detailed RWI-GEO-GRID information are added. (Coefficient estimates are reported in Table A.2 in the appendix.) Apparently, when controls for locality characteristics are excluded in the estimation, the effects of wind turbines are overestimated, reflecting the fact that windmills tend to be installed in low-price regions.

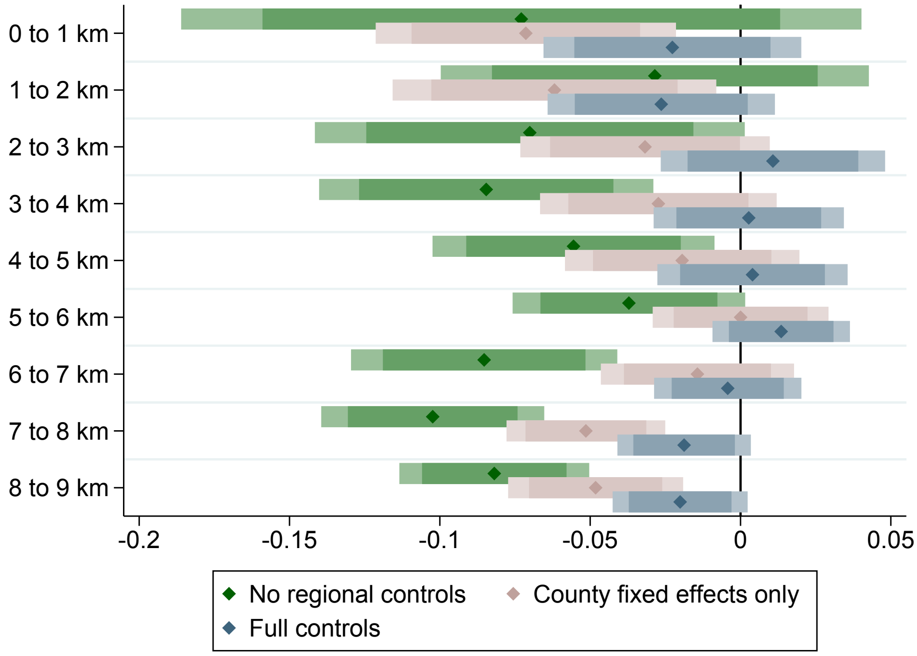
Figure 6: Effects of Wind Turbines on logged House Prices



Note: Standard errors are clustered at the GEO-Grid level.

To provide further evidence that the unconfoundedness assumption holds, we ran placebo regressions. In a first step, we drop from the estimation sample all "treated" houses, that is, those which had a wind turbine within 9 km when they were offered, instead focusing on houses where there was no turbine when they were offered, but where a turbine was constructed in the following years. We then estimate Equation 1 replacing the treatment dummies *distance* with placebo treatment dummies indicating the future presence of a wind turbine in a distance up to 9 km. To exclude anticipation effects, in addition to dropping actually treated houses, we also drop observations

Figure 7: Placebo Regression Results: Effects of Future Wind Turbines on logged House Prices



Note: Standard errors are clustered at the GEO-Grid level.

where a wind turbine was constructed within the two years following a house sale offer. Hence, there should be no treatment effect and the estimated coefficients can be interpreted as the selection effect of wind turbines in specific localities.

The resulting treatment effects are presented in Figure 7, while the OLS coefficient estimates are reported in Table A.5 in the appendix. The negative and significant coefficients on the treatment dummies in the "no local control setting" support the presumption that the placement of wind turbines is negatively correlated with surrounding house prices. However, the effects do not follow the decreasing pattern observed in our baseline estimation.

This finding still persists after adding municipality fixed effects, although the magnitude of many of the coefficients is lower. But, after including controls for our detailed small scale neighborhood characteristics from RWI-GEO-GRID, all coefficient estimates are not statistically different from zero. Also, there is no discernible pattern to the coefficient estimates, as they straddle both sides of zero. Hence, we are confident that we have captured all the factors influencing the placement of wind turbines that are associated with house prices via our detailed small-scale neighborhood data.

6 Summary and Conclusions

Wind power is among the most promising renewable energy technologies, as its high electricity generation potential is accompanied by relatively low generation cost. Yet, there is also increasing international evidence that wind turbines cause persistent negative externalities: In addition to posing hazards for birds and bats, turbines make noise and affect the aesthetic appeal of the landscape. Ultimately, these impacts may bear negatively on house prices. Despite the rapid expansion of wind power capacities in recent decades, though, empirical evidence on the effect of nearby wind turbines on real estate prices is scant for Germany.

Using asking prices from Germany's leading online broker and a hedonic pricing model coupled with a machine leaning algorithm, we fill this gap by analyzing the effect of wind turbines on prices of surrounding single-family houses. Accounting for detailed property and locality characteristics, we estimate an average treatment effect of up to 7.1% for houses within 1 km distance to the next wind turbine, an effect that fades out at a distance between 8 and 9 km.

Identifying the most important interaction terms by a machine leaning algorithm, we add to the literature by estimating heterogeneous treatment effects: While the prices of houses close to urban environments are not affected by nearby windmills, houses in rural areas suffer from remarkable devaluation. This effect is even more pronounced for old buildings built prior to 1949, whose asking prices decrease by up to 23%.

Our findings can be explained by differences in the appearance of the landscape and preferences of the local population. While the urban population is accustomed to living in an industrialized and dynamic environment, inhabitants of rural areas may lose the impression of pristine nature and tranquility when noise, rotation, and shadow flickers appear. Altogether, our results illustrate that while electricity generation via wind turbines may have global benefits, these are accompanied by substantial local externalities and environmental costs, primarily borne by rural communities close to wind turbines.

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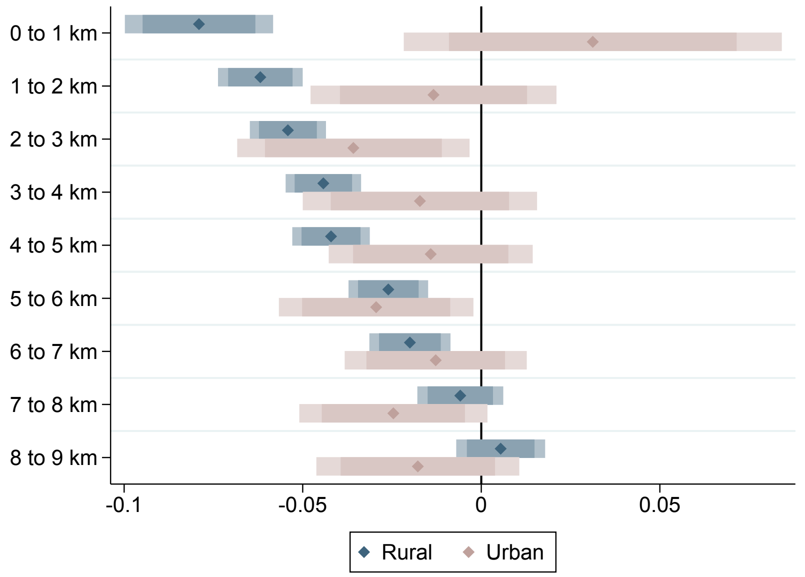
Appendix

Table A.1: Descriptive Statistics of the Treatment and Control Group

	Treatment Group		Control Group	
	Mean	Standard Deviation	Mean	Standard Deviation
Housing characteristics:				
Asking price in €	241,025.21	164,986.92	331,201.15	246,372.81
Year of construction	1979.24	37.19	1980.00	36.44
Living space in m^2	151.30	57.97	157.87	64.32
Lot size in m^2	704.85	557.34	626.62	493.40
Number of rooms	5.38	1.76	5.54	1.79
Detached house	0.60	-	0.54	-
Semidetached house	0.16	-	0.19	-
Other house type	0.06	-	0.07	-
Terrace house	0.03	-	0.04	-
Mid-terrace house	0.06	-	0.06	-
End-terrace house	0.03	-	0.04	-
Bungalow	0.03	-	0.02	-
Villa	0.03	-	0.04	-
Locality characteristics:				
Purchasing power per capita (in €)	20,808.36	3,588.27	22,615.24	4,662.33
Total inhabitants per km^2	1,684.74	1,588.06	2,105.22	1,868.65
Unemployment rate (in %)	6.39	3.96	5.23	3.78
Foreigners (in %)	6.02	5.43	7.79	6.08
Number of buildings	415.89	302.62	468.01	309.49
Share of inhabitants aged 0-20	19.61	2.72	19.37	2.57
Share of inhabitants aged 20-35	16.08	2.93	16.42	2.98
Share of inhabitants aged 35-45	14.29	2.12	14.71	2.20
Share of inhabitants aged 45-55	16.62	1.89	16.19	1.80
Share of inhabitants aged 55-65	12.76	1.88	12.59	1.84
Share of inhabitants aged 65+	20.64	1.86	20.72	1.87
Distance to city center (in km)	25.12	19.55	23.90	21.71
Number of Observations:	1,037,399		1,818,067	

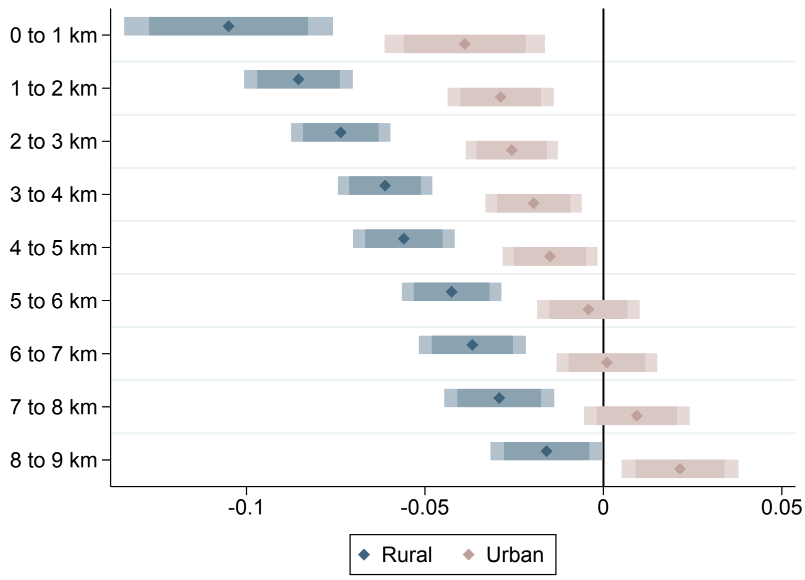
Note: Treatment group includes all houses with a wind turbine in 9 km, control group those further away than 9 km from the next turbine.

Figure A1: Effects of a Wind Turbine on logged House Prices of Rural and Urban Houses (5km Radius)



Note: Standard errors are clustered at the GEO-Grid level.

Figure A2: Effects of a Wind Turbine on logged House Prices of Rural and Urban Houses (20km Radius)



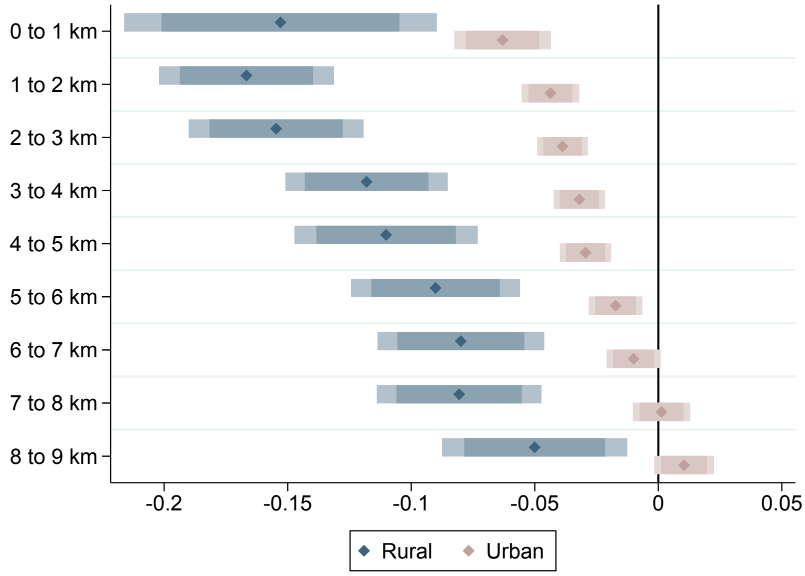
Note: Standard errors are clustered at the GEO-Grid level.

Table A.2: OLS Estimation Results of Equation 1 with Various Sets of Control Variables

	No Regional Controls		Local Fixed Effects Only		Full Controls	
	Coefficients	Standard Errors	Coefficients	Standard Errors	Coefficients	Standard Errors
Wind turbine within						
1 km distance	-0.395**	(0.0115)	-0.148**	(0.00881)	-0.0735**	(0.00763)
1 to 2 km distance	-0.364**	(0.00649)	-0.127**	(0.00529)	-0.0615**	(0.00424)
2 to 3 km distance	-0.328**	(0.00608)	-0.105**	(0.00490)	-0.0560**	(0.00390)
3 to 4 km distance	-0.301**	(0.00611)	-0.0834**	(0.00487)	-0.0441**	(0.00381)
4 to 5 km distance	-0.265**	(0.00682)	-0.0718**	(0.00494)	-0.0416**	(0.00384)
5 to 6 km distance	-0.221**	(0.00705)	-0.0528**	(0.00502)	-0.0294**	(0.00394)
6 to 7 km distance	-0.191**	(0.00775)	-0.0494**	(0.00505)	-0.0253**	(0.00393)
7 to 8 km distance	-0.164**	(0.00910)	-0.0314**	(0.00548)	-0.0139**	(0.00413)
8 to 9 km distance	-0.128**	(0.00863)	-0.0130	(0.00570)	-0.000786	(0.00427)
Housing characteristics	Yes		Yes		Yes	
Locality characteristics	No		No		Yes	
Year dummies	Yes		Yes		Yes	
Municipality dummies	No		Yes		Yes	
Number of Observations:	2,855,466		2,855,466		2,855,466	
R^2	0.435		0.667		0.711	

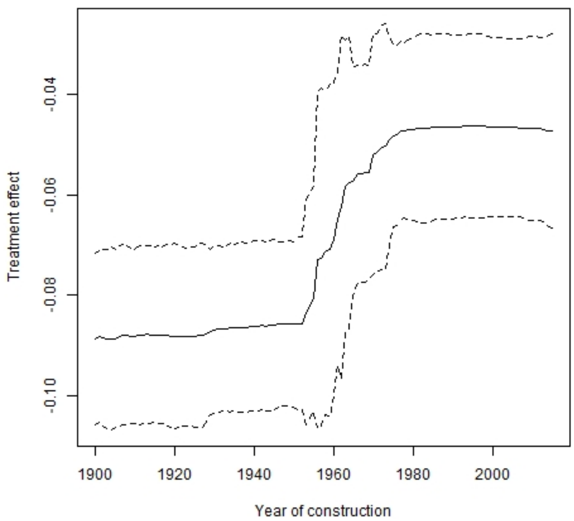
Note: $**$ and $*$ indicate statistical significance at the 1% and 5% level, respectively; standard errors are clustered at the GEO-Grid level.

Figure A3: Effects of a Wind Turbine on logged House Prices of Rural and Urban Houses (50km Radius)



Note: Standard errors are clustered at the GEO-Grid level.

Figure A4: Conditional Average Treatment Effect (CATE) of a Wind Turbine Conditional on the Year of Construction



Note: Confidence Intervals are given by dashed lines.

Table A.3: OLS Regression Results of Equation 1 with Rural/Urban Interaction

	Coefficients	Standard Errors
Wind turbine within		
1 km distance	-0.0841**	(0.00882)
1 to 2 km distance	-0.0697**	(0.00482)
2 to 3 km distance	-0.0610**	(0.00445)
3 to 4 km distance	-0.0492**	(0.00438)
4 to 5 km distance	-0.0486**	(0.00459)
5 to 6 km distance	-0.0325**	(0.00457)
6 to 7 km distance	-0.0251**	(0.00491)
7 to 8 km distance	-0.00971	(0.00521)
8 to 9 km distance	0.000229	(0.00536)
Interaction		
1 km distance * urban	0.0681**	(0.0153)
1 to 2 km distance * urban	0.0595**	(0.00997)
2 to 3 km distance * urban	0.0442**	(0.00845)
3 to 4 km distance * urban	0.0363**	(0.00866)
4 to 5 km distance * urban	0.0424**	(0.00817)
5 to 6 km distance * urban	0.0239**	(0.00881)
6 to 7 km distance * urban	0.0199*	(0.00834)
7 to 8 km distance * urban	0.00563	(0.00905)
8 to 9 km distance * urban	0.00634	(0.00935)
Housing characteristics	Yes	
Locality characteristics	Yes	
Year dummies	Yes	
Municipality dummies	Yes	
Number of Observations:	2,855,466	
R^2	0.687	

Note: $**$ and $*$ indicate statistical significance at the 1% and 5% level,respectively; standard errors are clustered at the GEO-Grid level.

Table A.4: OLS Regression Results of Equation 1 with Old/New Interaction

	Coefficients	Standard Errors
Wind turbine within		
1 km distance	-0.0449**	(0.00666)
1 to 2 km distance	-0.0319**	(0.00437)
2 to 3 km distance	-0.0281**	(0.00398)
3 to 4 km distance	-0.0225**	(0.00395)
4 to 5 km distance	-0.0223**	(0.00389)
5 to 6 km distance	-0.0150**	(0.00412)
6 to 7 km distance	-0.00735	(0.00400)
7 to 8 km distance	-0.00113	(0.00425)
8 to 9 km distance	0.00538	(0.00413)
Interaction		
1 km distance * build until 1949	-0.189**	(0.0314)
1 to 2 km distance * build until 1949	-0.191**	(0.0112)
2 to 3 km distance * build until 1949	-0.166**	(0.00949)
3 to 4 km distance * build until 1949	-0.134**	(0.00966)
4 to 5 km distance * build until 1949	-0.116**	(0.0116)
5 to 6 km distance * build until 1949	-0.0861**	(0.00987)
6 to 7 km distance * build until 1949	-0.0947**	(0.0125)
7 to 8 km distance * build until 1949	-0.0794**	(0.0121)
8 to 9 km distance * build until 1949	-0.0380**	(0..0134)
Housing characteristics	Yes	
Locality characteristics	Yes	
Year dummies	Yes	
Municipality dummies	Yes	
Number of Observations:	2,855,466	
R^2	0.689	

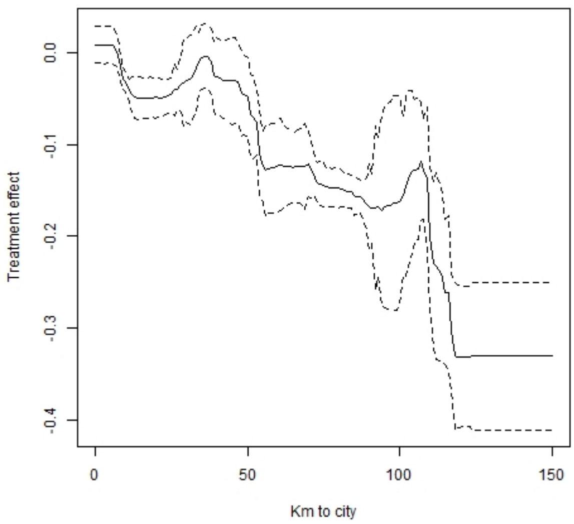
Note: $**$ and $*$ indicate statistical significance at the 1% and 5% level,respectively; standard errors are clustered at the GEO-Grid level.

Table A.5: OLS Estimation Results of Equation 1 with Placebo Treatment and Various Sets of Control Variables

	No Regional Controls		Local Fixed Effects Only		Full Controls	
	Coefficients	Standard Errors	Coefficients	Standard Errors	Coefficients	Standard Errors
No Wind turbine within						
1 km distance	-0.0729	(-1.66)	-0.0714**	(-3.68)	-0.0227	(-1.36)
1 to 2 km distance	-0.0285	(-1.03)	-0.0619**	(-2.96)	-0.0264	(-1.80)
2 to 3 km distance	-0.0701*	(-2.52)	-0.0318*	(-1.97)	0.0108	(0.74)
3 to 4 km distance	-0.0846**	(-3.92)	-0.0273	(-1.79)	0.00274	(0.22)
4 to 5 km distance	-0.0555**	(-3.05)	-0.0194	(-1.28)	0.00399	(0.32)
5 to 6 km distance	-0.0371*	(-2.47)	0.0000343	(0.00)	0.0135	(1.52)
6 to 7 km distance	-0.0853**	(-4.96)	-0.0143	(-1.15)	-0.00425	(-0.45)
7 to 8 km distance	-0.102**	(-7.11)	-0.0514**	(-5.02)	-0.0188*	(-2.18)
8 to 9 km distance	-0.0819**	(-6.68)	-0.0482**	(-4.27)	-0.0201*	(-2.30)
Housing characteristics	Yes		Yes		Yes	
Locality characteristics	No		No		Yes	
Year dummies	Yes		Yes		Yes	
Municipality dummies	No		Yes		Yes	
Number of Observations:	986,862		986,862		986,862	
R^2	0.400		0.686		0.733	

Note: ∗∗ and ∗ indicate statistical significance at the 1% and 5% level, respectively; standard errors clustered on GEO-Grid level.

Figure A5: Conditional Average Treatment Effect (CATE) of a Wind Turbine Conditional on the Distance to the Next City



Note: Confidence Intervals are given by dashed lines.

Stephen Gibbons

Gone with the wind: valuing the visual impacts of wind turbines through house prices

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Gone with the wind: valuing the visual impacts of wind turbines through house prices

Stephen Gibbons[a]

March 2015

Key words: Housing prices, environment, wind farms, infrastructure, energy

JEL codes: R3,Q4, Q51

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Abstract:
This study provides quantitative evidence on the local benefits and costs of wind farm developments in England and Wales, focussing on their visual environmental impacts. In the tradition of studies in environmental, public and urban economics, housing sales prices are used to reveal local preferences for views of wind farm developments. Estimation is based on quasi-experimental research designs that compare price changes occurring in places where wind farms become visible, with price changes in appropriate comparison groups. These groups include places close to wind farms that became visible in the past, or where they will become operational in the future and places close to wind farms sites but where the turbines are hidden by the terrain. All these comparisons suggest that wind farm visibility reduces local house prices, and the implied visual environmental costs are substantial.

Key words: Housing prices, environment, wind farms, infrastructure, energy

JEL codes: R3,Q4, Q51

1 Introduction

Renewable energy technology clearly provides potential global environmental benefits in terms of reduced CO2 emissions and slower depletion of natural energy resources. However, like most power generation and transmission infrastructure, the plant, access services and transmission equipment associated with renewable electricity generation may involve environmental costs. This is particularly so in the case of wind turbine developments, where the sites that are optimal in terms of energy efficiency are typically in rural, coastal and wilderness locations that offer many natural environmental amenities. These natural amenities include the aesthetic appeal of landscape, outdoor recreational opportunities and the existence values of wilderness habitats. The visual impacts of these 'wind farms' may be especially important because they are often on high ground with extensive visibility. Although views on their aesthetic appeal are mixed, there is evidently considerable dislike for their visual impact on the landscape, with 23% of respondents in a poll of 1001 residents in Scotland in 2010 agreeing or strongly agreeing that wind farms "are, or would be, ugly and a blot on the landscape" (You Gov 2010). It should be noted, however, that only 51% of respondents had actually seen a wind farm in real life. In addition to these potential impacts on landscape, residents local to operational wind turbines have reported health effects related to visual disturbance and noise (e.g. Bakker et al 2012, Farbouda et al 2013).

The UK, like other areas in Europe and parts of the US has seen a rapid expansion in the number of these wind turbine developments since the mid-1990s. Although these wind farms can offer various local community benefits, including shared ownership schemes, community payments and the rents to land owners, in the UK, and elsewhere in Europe, wind farm developments have faced significant opposition from local residents and other stakeholders with interests in environmental preservation. This opposition suggests that the environmental costs may be important. The issue is highly controversial, given that opinion polls and other surveys generally indicate majority support of around 70% for green energy, including windfarms, (e.g. results from the Eurobarometer survey in European Commission 2006). This contradiction has led to accusations of 'nimbyism' (not in my backyard-ism), on the assumption that it is the same people opposing wind farm developments in practice as supporting them in principle. There is perhaps less of a contradiction when it is considered that the development of wind farms in rural locations potentially represents a transfer from residents in these communities and users of natural amenities (in the form of loss of amenities) to the majority of the population who are urban residents (in the form of energy). Other possible explanations for the tension between public support and private opposition to wind energy developments are discussed at length in Bell et al (2007).

This paper provides quantitative evidence on the local benefits and costs of wind farm developments in England and Wales, focussing on the effects of wind turbine visibility, and the implied cost in terms of loss of visual landscape amenities. In the tradition of 'hedonic' studies in environmental, public and urban economics, housing sales prices are used to reveal local preferences for views of wind farms. This is feasible, because wind farms in England and Wales are often close to and visible from residential areas in rural, semi-rural and even urban locations, so the context provides a large sample of housing sales that are potentially affected (at the time of writing, around 1.8% of residential postcodes are within 4 km of operational or proposed wind farm developments). The study offers a significant advance over previous studies, which have mostly been based on relatively small samples of housing transactions and cross-sectional price comparisons. Estimation in this current work is based on quasi experimental, difference-in-difference based research designs that compare price changes occurring in postcodes where wind farms become visible, with postcodes in appropriate comparison groups. These groups include: places where wind farms became visible in the past, or where they will become visible in the future and places close to where wind farms became operational but where the turbines are hidden by the terrain. The postcode fixed effects design implies that the analysis is based on repeat sales of the same, or similar housing units within postcode groups (typically 17 houses grouped together). Kuminoff, Parmeter and Pope (2010) provide a discussion of the advantages of quasi-experimental approaches of this type in the context of hedonic methods for environmental valuation.

The overall finding is that operational wind farm developments reduce prices in locations where the turbines are visible, relative to where they are not visible, and that the effects are causal. This price reduction is around 5-6% on average for housing with a visible wind farm within 2km, falling to under 2% between 2-4km, and to near zero between 8-14km, which is at the limit of likely visibility. Evidence from comparisons with places close to wind farms, but where wind farms are less visible suggests that the price reductions are associated with turbine visibility. As might be expected, large visible wind farms have much bigger impacts that extend over a wider area.

The remainder of the paper is structured as follows. Section 2 discusses background policy issues and the existing literature on wind farm effects. Section 3 outlines the data used for the analysis. Section 4 describes the empirical strategy and Section 5 the results. Finally, Section 6 concludes.

2 Wind farm policy and the literature on their local effects

In England and Wales, many wind farms are developed, operated and owned by one of a number of major energy generation companies, such as RES, Scottish Power, EDF and E.ON, Ecotricity, Peel Energy, though some are developed as one-off enterprises. Currently, wind farms are potentially attractive businesses for developers and landowners because the electricity they generate is eligible for Renewables Obligation Certificates, which are issued by the sector regulator (Ofgem) and guarantee a price at premium above the market rate. This premium price is subsidised by a tariff on consumer energy bills. The owners of the land on which a wind farms is constructed and operational will charge a rent to the wind farm operator. Media reports suggest that this rent could amount to about £40,000 per annum per 3 MW turbine (Vidal 2012).

The details of the procedures for on-shore wind farm developments in England and Wales have evolved over time, but the general arrangement is that applications – in common with applications for most other types of development - have to pass through local planning procedures. These procedures are administered by a Local Planning Authority, which is generally the administrative Local Authority, or a National Park Authority. Very small single wind turbines (below the scale covered by the current analysis) can sometimes be constructed at a home, farm or industrial sites within the scope of 'permitted development' that does not require planning permission. The planning process can take a number of years from the initial environmental scoping stage to operation, and involves several stages of planning application, environmental impact assessment, community consultation and appeals. [1] Once approved, construction is relatively quick. According to public information from the European Wind Energy Association[2], a 10 megawatt wind farm (3-4 turbines) can be constructed in 2 months, and a larger 50 megawatt wind farm in 6 months (the average size wind farm in this current study is around 18 Mw). Large wind farms (over 50 Mw) need approval by central government. Offshore wind farms are also subject to a different process and require approval by a central government body.

Wind farms have potential local economic benefits of various types. Interesting qualitative and descriptive quantitative evidence on the community and local economic development benefits of

[1] E.g. Peel Energy http://www.peelenergy.co.uk/ provide indicative project planning timelines for their proposed wind farm developments

[2] http://www.ewea.org/wind-energy-basics/faq/ accessed February 2014

wind farms in Wales is provided by Munday et al (2011). Potential benefits include the use of locally manufactured inputs and local labour, discounted electricity supplies, payments into community funds, sponsorship of local events, environmental enhancement projects, and tourism facilities. They argue that the local economic development effects have been relatively limited, although in many of the communities surveyed (around 21 out of 29 wind farms) payments were made to community trusts and organisations, and these contributions can be quite substantial – at around £500-£5000 per megawatt per annum. Based on these figures, a mid-range estimate of the community funds paid out to affected communities in Wales would be about £21,000 per wind farm per year. For the US, Kahn (2013) argues that wind farm counties generate benefits for their communities because the revenues to land owners spill over to the community in general, through lower property tax rates and improved public expenditures. This direct link between local taxation and school resources is more important in the US, than in the UK where schooling is financed mainly through central government grants. Using data and fairly descriptive quantitative evidence from counties in Texas, he finds some signs of increases in school resources relative to non-wind farm counties and lower property tax rates, and no evidence that wind farms have deterred higher-educated residents from moving in to the area.

There is also an extensive literature on attitudes to wind farm developments, the social and health aspects, and findings from impact assessments and planning appeals. Most existing evidence on preferences is based on surveys of residents' views, stated preference methods and contingent valuation studies and is mixed in its findings.

There have been several previous attempts to quantify impacts on house prices in the US. Hoen et al (2011) apply cross-sectional hedonic analysis, based on 24 wind farms across US states. Their study is interesting in that it makes the comparison between price effects at places where turbines are visible compared to places where nearby turbines are non-visible (a technique which is applied later in the current paper) but finds no impacts. For the UK, Sims et al (2007, 2008) also conduct a cross-sectional hedonic analysis of around 900 property sales, which all postdate construction, near three wind farms in Cornwall. Again this study finds no effects. One study with a larger housing sample size Lang et al (2014), looks at 10 small-scale wind farms in suburban and urban locations in Rhode Island, all but one of which are single-turbine sites. The authors provide difference-in-difference estimates and repeat sales estimates, based on changes in prices over a 14 year interval. Their sample has 2670 housing transactions within 1 mile (2.25km) over this period, with 338 sales post-dating construction. They report no significant effects on housing prices from the wind farms, but these are small wind power developments in an area that is already highly developed rather than rural. The results are therefore difficult to generalise to the case of large scale wind farms like those in the UK and elsewhere in the US and Europe.[3] Even so, the point estimates are in some cases large, with the repeat sales analysis suggesting falls of more than 6% within 2 miles after announcement of the wind farms, although the estimates are rarely statistically significant.

Another study from the US, Hoen at al (2013), attempts a difference-in-difference comparison for wind farms, but using cross-sectional comparisons between houses at different distances from the turbines. This study uses fairly sparse data on 61 wind farms across nine US states. The sample contains over 50,000 transactions, but very few transactions in the areas near the wind farms: only 1198 transactions reported within 1 mile of current or future turbines (p20) and only 300 post-dating construction. Their cross-sectional difference-in-difference comparison is between places beyond and within 3 miles of a wind farm site and the research design does not exploit price changes or repeat sales. The conclusions of the paper are that there is ‘no statistical evidence that

[3] Their regressions also control for an unspecified number of city-by-quarter fixed effects, which seem likely to absorb much of the impact of the wind farms on prices making it difficult to detect any effects even if they exist.

home values near turbines were affected' by wind turbines, which is true in a literal sense. However, as in Lang et al (2014), the point estimates indicate some quite sizeable effects; it is the fact that the point estimates are imprecise and have big standard errors that makes them statistically uninformative. A similar conclusion is reached, for similar reasons, in Vyn and Mcullough (2014) who study the impact of turbines in a large windfarm in Canada on neighbouring farmland and residential sales. Their dataset includes over 5000 residential sales and over 1500 farm sales, and the authors went to considerable trouble to determine turbine visibility. Sadly though, only a very small number of sales occur after turbine construction. A total of 18 sales occur within 1km and 79 within 5km (their Table 2) after the wind farm was built. Inevitably this means the results are not very informative and are very imprecise. As in many previous studies, the standard errors are so large and the point estimates vary so much from specification to specification, that the authors can only conclude that "while the results indicate a general lack of significantly negative effects across the properties examined in this study, this does not preclude any negative effects from occurring on individual properties" and note that "a recent appraiser's report on the impacts of Melancthon's wind turbines … found that the values of five specific properties in close proximity to turbines declined by up to 59%." (Vyn and Mcullough p.388).

In contrast, the current study has nearly 38,000 quarterly, postcode-specific housing price observations over 12 years, each representing one or more housing transactions within 2km of wind farms (about 1.25 miles). Turbines are potentially visible for 36,000 of these. There is therefore a much greater chance than in previous work of detecting price effects if these are indeed present.

3 Data

Information on wind-farm location (latitude and longitude), characteristics and dates of events was provided by RenewableUK, a not for profit renewable energy trade association (formerly BWEA). This dataset records dates of operation and other events related to their planning history, number of turbines, MW capacity and height of turbines (to tip). The dates in these data relate to the current status of the wind farm development, namely application for planning, approval, withdrawal or refusal, construction and operation. Unfortunately these public data do not provide a complete record of the history for a given site, because the dates of events are updated as the planning and construction process progresses. Therefore, for operational sites, the dates of commencement of operation are known, but not the date when planning applications were submitted, approved or construction began. This limits the scope of investigation of the impact of different events in the planning and operation process, other than for cases where there is a final event recorded, and this version of the paper makes use of operational wind farms only.

A GIS digital elevation model (DEM)[4] was combined with this wind-farm site and height data to generate 'viewsheds' on 200m grid. These viewsheds were used to differentiate residential postcodes (geographical units with approximately 17 houses) into those from which the wind farm is visible, and those from which it is less likely they are visible, using information on the underlying topography of the landscape. These viewsheds provide approximate visibility indicators, both in terms of the 200m geographical resolution of the view sheds (necessary for manageable computation times), and because they are based on wind-farm centroids, not individual turbines. This means that in the case of large wind farms, turbines may be visible from

[4] GB SRTM Digital Elevation Model 90m, based on the NASA Shuttle Radar Digital Topography Mission and available from the EDNIA ShareGeo service http://www.sharegeo.ac.uk/handle/10672/5

locations which the procedure classifies as non-visible, given a large wind turbine array can extend over 1km or more. However, the median wind farm development in the data contains only 6 turbines, so the errors introduced by basing visibility on site centroids are likely to small. Note the error will in general result in mis-classification of sites from which the turbines are deemed non-visible, given that if the tip of a turbine at the centroid of the site is visible, it is almost certain that at least one turbine is visible. The viewsheds also take no account of intervening buildings, trees and other structures, because Digital Surface Models which take account of such features are not yet available for the whole of England and Wales. As a further refinement, to eliminate cases where visibility was highly ambiguous, I calculated the rate of change of visibility from one 200m grid cell to the next, and dropped postcodes in cells in the top decile of this visibility gradient. In general, misclassifications in terms of visibility, and measurement error in distance to wind turbines will tend to attenuate the coefficients in regression-based estimates. This implies that the results that follow may, if anything, under-estimate the effects of wind farm distance and visibility on prices.

Given the focus of this study on the visual impacts of wind farms in rural areas, a number of single-turbine wind farms in urban areas and industrial zones were excluded from the analysis (around 21 operational turbines are dropped). Land cover estimates were used first to restrict the analysis to wind farms outside zones with continuous urban land cover. Some additional turbines were eliminated on a case-by-basis where the information available in the wind farm data, and reference to web-based maps and information sources, suggested that turbines were on industrial sites within or close to major urban areas. The land cover at the wind farm centroid was obtained by overlaying the wind farm site data with 25m grid based land cover data (LandCoverMap 2000 from the Centre for Ecology and Hydrology). Land cover was estimated from the modal land cover type in a 250m grid cell enclosing the wind farm centroid. In cases where no mode exists (due to ties), the land cover in the 25 m grid cell enclosing the centroid was used.

Housing transactions data come from the England and Wales Land Registry 'price paid' housing transactions data, from January 2000 to the first quarter of 2012. Data going back to 1995 are available at the time of writing, but was not yet available at the time the dataset for this analysis was created. The 'price paid' data include information on sales price, basic property types – detached, semi-detached, terraced or flat/maisonette – whether the property is new or second-hand, and whether it is sold on freehold or leasehold basis. The housing transactions were geocoded using the address postcode and aggregated to mean values in postcode-by-quarter cells to create an unbalanced panel of postcodes observed at quarterly intervals (with gaps in the series for a postcode when there are no transactions in a given quarter). For a small subset of the data, floor area and other attributes of property sales can be merged from the Nationwide building society transactions data. Demographic characteristics at Output Area (OA) level from the 2001 Census were merged in based on housing transaction postcodes. These additional characteristics are used in some robustness checks which appear later in the empirical results.

Postcode and wind farm visibility data were linked by first forming a panel of postcodes at running quarterly (3 month) intervals over the period January 2000-March 2012. The cumulative number of operational turbines within distance bands of 0-1km, 1-2km, 2-4km, 4-8km and 8-14km of each postcode was then imputed at quarterly intervals by GIS analysis of the information on site and postcode centroids. The 14km limit is set in part to keep the dataset at a manageable size, but also because as the distance to the wind farm increases, the number of other potential coincident and confounding factors increases, making any attempt to identify wind farm impacts less credible. Existing literature based on field work suggests that large turbines are potentially perceptible up to 20km or more in good visibility conditions, but 10-15km is more typical for casual observer and details of individual turbines are lost by 8km (University of Newcastle 2002). In the next step, the site viewsheds were used to determine whether wind-farm sites are visible or not visible from each postcode in each quarter, again using GIS overlay techniques. Additional GIS analysis with the Digital Elevation Model provided estimates of the elevation, slope and aspect (North, East, South and West in 90 degree intervals) of the terrain at each postcode, plus visibility of coastline for use in a robustness check. These are potentially important control variables, because places with good views of wind farms may have good views generally, be more exposed to wind, or have more favourable aspects, and these factors may have direct effects on housing prices.

Finally, the housing transactions and wind farm visibility data were linked by postcode and quarter to create an end product which is an unbalanced panel of postcode-quarter cells, with information on mean housing prices and characteristics, the cumulative number of visible and non-visible operational turbines within the distance bands, plus additional variables on terrain and demographics. Note, prices in quarter t are linked to the turbine data at t-1, so although the price data extends to the first quarter of 2012, only wind farm developments up to the last quarter of 2011 are utilised. The next section describes the methods that are applied using these data to estimate the house price effects of wind farm developments.

4 Estimation strategy

The research design involves fixed-effects, regression-based difference-in-difference methods. In all cases, the research strategy is to compare the average change in housing prices in areas where and when wind farms become operational and visible, with the average change in housing prices in some comparison group.

4.1 Comparing the effects of new wind farms with existing and future wind farms

The simplest approach is to compare the price changes occurring around the time a wind farm becomes visible and operational, with the price changes occurring in comparable areas where wind farms are already visible and operational or where they will become so in the future. The idea is that postcodes close to existing or future wind farm locations and where these wind farms are or will be visible, provide a suitable counterfactual for places where new wind farms are becoming operational and visible in the current period. These postcodes close to and with views of new, existing and future wind farms are likely to be similar to each other in respect of: a) being physically suitable for wind farm developments; b) being viable for development in terms of the planning and construction process; and c) having topography that means that turbines are likely to be visible.

To implement this approach, I estimate the following regression specification, on the sample of postcodes which had visible turbines within a given distance radius at the beginning of the study period (2000), or will have visible turbines within these radii or bands by the end of it (2011)[5]:

$$\ln price_{it} = \sum_k \beta_k (visible,\, j_k < dist < k, operational)_{it-1} + x_{it}'\gamma + f\left(i,t\right) + \varepsilon_{it} \qquad (1)$$

Here $price_{it}$ is the mean housing transaction price in postcode *i* in quarter *t*. The variable capturing exposure to wind-farm developments is $(visible, j_k < dist < k, operational)_{it-1}$. This is a dummy (1-0)

[5] More precisely, a postcode is included in the sample for estimating (1) if it has a visible wind turbine development within the specified distance band before January 2000 or if turbines become visible over the course of the study period from 2000 to 2011. In this sample of postcodes the treatment indicator equals 1 for at least one quarter over the sample period. A postcode that has, for example, a visible, operational wind farm within 4km opening in the last quarter of 2004 will be included in the sample, but will have $(visible, 0 < dist < k, operational)_{it-1}$ = 0 in all quarters up to t corresponding to the first quarter of 2005, and $(visible, 0 < dist < k, operational)_{it-1}$ = 1 in all quarters thereafter. Postcodes with at least one visible, operational turbine from the beginning of the study period are included in the sample, but have the indicator $(visible, 0 < dist < k, operational)_{it-1}$ = 1 throughout.

treatment variable, indicating that postcode *i* has at least one visible-operational turbine between j_k and *k* km distance in the previous quarter. Vector x_{it} is an optional set of control variables, including housing characteristics. The function $f(i,t)$ represents a set of general geographical and time effects which will be controlled for using postcode fixed effects plus interactions between geographical and time dummies, as described in more detail below. The coefficient of interest β_k is the average effect on housing prices of wind farm turbines visible within distance band j_k-k . The sign of β_k is ambiguous a priori, since it depends on the net effects of preferences for views of wind farms, the impact of noise or visual disturbance – at least for properties very close to the turbines – and other potential local gains or losses, such as spillovers from land owner rents, shares in profits, community grants, or employment related to turbine maintenance and services.

This wind farm visibility indicator for a given postcode $(visible, j_k < dist < k, operational)_{it-1}$ is an interaction between an indicator that turbines are potentially visible from the postcode ($visible_i$), an indicator that these turbines are within a given distance band of the postcode ($j_k < dist_i < k$), and a 'post-policy' indicator which indicates that the turbines have been built and have become operational ($operational_{it-1}$). [6] This date of operation is taken as the date around which the wind farms impact on prices because my data contain no information on the date when the wind farm development was announced or when construction started or finished.

Two versions of the distance specifications in (1) are used in the empirical work. I start with the simplest specifications in which the regressions are estimated for different values of *k* (1km, 2km, 4km, 8km, 14km) and $j_k = 0$, i.e β_k estimates the effects of visible wind farms within a radius k.

[6] Note, it is not necessary to explicitly control for the separate components (*visible*, $j_k < dist < k$ and *operational*) because these are subsumed through the specification of geographical and time fixed effects $f(i,t)$ described below.

The estimation sample is restricted to postcodes with potentially visible turbines within distance *k*. In the second case, a series of distance band indicators is used (0 < distance ≤ 1km, 1km < distance ≤ 2km, 2km < distance ≤ 4km, 4km < distance ≤ 8km and 8km < distance ≤ 14km) in a single regression, and the sample is restricted to postcodes with visible turbines within the maximum 14km. The distance thresholds are chosen somewhat arbitrarily in order to give reasonably detailed delineation of the distance decay close to wind farm sites, while allowing for potential impacts up towards the limits of visibility.

Crucially, specification (1) must allow for unobserved components which vary over time and space $f(i,t)$ which are potentially correlated with the wind farm visibility indicator. This correlation with the geographical effects occurs because wind farms are not randomly assigned across space and postcodes close to wind farms and where turbines are visible may not be comparable to postcodes further away in terms of the other amenities that affect housing process. The correlation with the time effects occurs because the number of wind farms is growing over time, so there is obviously a spurious correlation between any general trends in prices over time and the indicator of wind farm visibility.

It is therefore essential to control in a quite general way for geographical fixed effects and time trends that are related to wind farm proximity and visibility. This is done firstly through the restriction to postcodes that have, or will have, visible wind farm developments close by. Secondly, postcode fixed effects are eliminated using the within-groups transformation (i.e. differences in the variables from postcode-specific means) and common time effects eliminated by including quarter-specific dummies (i.e. for the 48 quarters spanned by the data). Furthermore, in the distance-band version of the specification, separate sets of year dummies for each distance band, $j_k < dist < k$, are included control for differences in the price trends in these different distance bands (i.e. interactions between $j_k < dist < k$ dummies and year dummies). Additional time varying geographical effects are captured by interactions between year dummies, and dummies for categories of postcode elevation (0-25m, 26-50m, 51-100, >100m), slope (0-0.5%, 0.51-1%, 1.01-1.5%, 1.51-2.5%, >2.5%), and aspect (315-45 degrees, 46-135 degrees, 136-225 degrees, 226-316 degrees). These terrain variables are potentially important, because wind farm visibility depends on the elevation, slope and direction of the land at the postcode location. Some supplementary specifications include region-by-year dummies to control for general spatial trends, where regions are defined by splitting the sample into north, south east and west geographical quadrants.

Since the specification controls for postcode fixed effects, the estimation method exploits changes in average prices between the post-operation and pre-operation periods and β_k is estimated from postcodes that have housing transaction observations before and after a wind farm becomes operational. However, postcodes that have sales only before, or only after wind farm operations, including wind farms visible at the start of the study period in 2000, form part of the control group and contribute to estimation of the time trends and other parameters that are common across postcodes. The estimates of β_k from the within-postcode fixed effects estimator should be interpreted as the average price change between the pre- and post-operation periods, given the time spanned by the housing sales data (not necessarily the step change in price occurring at the time of operation, nor the full long run price effect from the period prior to planning announcement to the post-operation period). Given the data and setting, the within-groups estimator which compares the post-operation average price with the pre-operation average price over the whole sample period, is preferable to a specification using differences between two time periods. This is because: a) there is unlikely to be a step-change in prices coincident with wind farm operation, both because price changes evolve slowly, and because there may be pre-operation price changes after announcement; and b) the panel is sparse and unbalanced, with missing periods where there are no price transactions in a given postcode, so working with differences over specific time intervals within postcodes would result in a large reduction in sample size (e.g. a 4 quarter difference can only be observed in postcodes where there happen to be sales observed 4 quarters apart).

4.2 Comparing the effects of visible and non-visible turbines

It is well known that difference-in-difference based research designs suffer from the problem of pre-existing differences in trends between the 'treatment' and 'control' groups. In the method described above, this problem is mitigated by using wind-farm locations as both treatment and control groups. Postcodes with existing visible-operational turbines, and postcodes with potentially visible turbines that become visible-operational in the future, provide information on the counterfactual price changes for postcodes in which turbines have just become visible-operational. However, this method may not completely take care of more subtle short run differential trends in the affected postcodes, e.g. if wind farms are intentionally or coincidentally targeted to particular places during periods in which these places have falling or rising prices relative to places that saw wind farm developments in the past, or will see them in the future. In addition, if the aim is to interpret β_k as the visibility impact of wind farms, estimates from (1) will be biased by any price effects arising through other channels such as local benefits, or costs due to noise.

To obtain cleaner estimates of the impacts of wind farm visibility, I augment specification (1) with additional treatment indicators, for postcodes close to wind-farms, but where the turbines are likely to be hidden from view by the landscape topography. This approach provides a powerful test of the robustness of the main findings on visibility, because the postcodes with non-visible-operational turbines within a given radius of the turbines are in the same geographical areas as the postcodes with visible turbines. These two visible and non-visible groups are thus likely to be closely comparable on unobserved dimensions, and subject to similar unobserved price trends arising through other causal channels. One concern might be that topographic features that obscure a wind farm from view from a property also reduce the noise level, meaning that comparisons between the visible and non-visible groups also capture differences in noise levels. In practice this is very unlikely. The predicted combined noise level from a wind farm with a ten turbine array, with each turbine emitting a typical 100dbA, falls to around 40dbA by 1km, which is below the background noise level in an average home. [7] At 2km the noise level is around 34dBA. Moreover, much of the nuisance noise from wind farms is low frequency, and low frequency sound in particular is not attenuated by large topographic features due to refraction. At distances beyond 1km, comparisons between groups with visible and non-visible turbines are very unlikely to pick up noise-related effects.

The structure of the regression specifications for these visible-non-visible comparisons is identical to (1) but the sample now includes the sample of postcodes with potentially visible-operational turbines plus the sample of postcodes which are close to the same set of turbines, but where these are non-visible. Accordingly, specification (2) uses a treatment indicator that is an interaction of an indicator that there are no visible wind farms (*non-visible*) at the postcode, that the postcode is within a given radius or distance band ($j_k < dist < k$)and the indicator that the turbines are operational (*operational*):

[7] Calculations based on the National Physical Laboratory wind turbine noise model http://resource.npl.co.uk/acoustics/techguides/wtnm/

$$
\begin{aligned}
\ln price_{it} = & \sum_k \beta_k (visible,\ j_k < dist < k, operational)_{it-1} \\
& + \sum_k \delta_k (non-visible,\ j_k < dist < k, operational)_{it-1} \\
& + x_{it}'\gamma + f\left(i,t\right) + \varepsilon_{it}
\end{aligned} \tag{2}
$$

In this setup, the estimated parameters δ_k are estimates of the effects on house prices of proximity to operational turbines, when there is no impact from the turbines being visible in the neighbourhood. These sign of these effects is theoretically ambiguous, for reasons discussed above for visible operational turbine, because there are potential community benefits and potential costs. If there are local community benefits, then the visibility parameters β_k will be underestimates of the costs associated with wind farm visibility, because these impacts are already partly compensated by these other benefits (as in the classic wage-price-amenity trade off in the Roback model of compensating wage and land price disparities in Roback 1982). However, the difference-in-difference-in-difference estimate of $\beta_k - \delta_k$ provides a cleaner estimate of the specific impact of wind farm visibility – i.e. the increase in the gap between house prices in places where wind farm sites are visible and where they are not visible, once the turbines are built. This estimate thus provides an explicit estimate of willingness to pay through housing expenditure to avoid views of wind turbines and estimate of the monetary value of the visual dis-amenity associated with them.

In these specifications with visible and non-visible indicators, the set of geographical-by-time effects is extended to include separate quarterly trends for postcodes with visible and non-visible turbines (i.e. interactions between $0 < dist < K$, *non-visible* and quarter dummies, and interactions between $0 < dist < K$, *visible* and quarter dummies, where K is the maximum radius included in the particular specification). As before the specification also includes separate sets of year dummies for each distance band (i.e. interactions between $j_k < dist < k$ dummies and year dummies) interactions of year dummies with elevation, slope and aspect indicators and control variables for property characteristics.

A number of other robustness checks are carried out to assess sensitivity to local price trends, changing composition of housing sales, and assumptions about the clustering of standard errors. These are described where they arise in the Results section below.

4.3 Specifications for effects by wind farm size

The set up described above is based around a treatment effect design with a simple 1-0 indicator of turbine visibility and operation, and thus implicitly estimates the effect of wind farms of average size. Clearly, the impacts are likely to differ by wind farm size (number of turbines) and there are likely to be interactions of size with distance, especially if visibility turns out to be an important influence on prices. I therefore estimate final specifications that look at the interactions between wind farm size and distance, using a similar set up to (1), but with separate indicators for the number of turbines visible and operational at each distance and the number of turbines.

5 Results

5.1 Descriptive figures and statistics

Figure 1 shows the historical development of non-urban wind turbines in England and Wales from the mid-1990s to 2011. By the end of 2011, these turbines could provide up to 3200mw of generating capacity, which, in principle, amounts to sufficient power for about 1.8 million homes (or around 7.7% of the 23.4 million households in England and Wales)[8]. Figure 2 illustrates the

[8] This figure is estimated from DECC 2013a and DECC 2013b as follows. Total UK electricity output from onshore and offshore wind was 15.5TWh in 2011 (DECC 2013a Table 6.4) from 6500MW total capacity. Scaling down to the capacity of 3200MW in England and Wales, suggests an output of 7.6 TWh from wind farms in England and Wales. Average UK domestic household electricity consumption is $4.2\text{x}10^{-6}$TWh, based on total domestic electricity consumption of 111.6TWh (DECC2013b, Table 5.1.2), and a figure of 26.4 million households in the UK (2011 Census). Therefore, wind farms in England and Wales could power approximately $7.6/4.2\text{x}10^{-6}$ = 1.8 million households.

evolution of the spatial distribution of these turbine sites between 2000 and 2011. These sites have, over the whole period, been predominantly in coastal and upland areas. These are often on the peripheries of areas that are valued for their natural beauty, although wind farms have not been permitted in National Parks. Examples are the Cornwall peninsula in the south west, Wales in the west, the Pennines in northern England, and around the coast Cumbria (the Lake District) in north west England. There are also concentrations around Sunderland in the north east, and Lincolnshire, Norfolk and the Wash in the east. In general, density has increased in these regions, rather than the distribution spreading across regions, although new wind farms have appeared in eastern central England in recent years. There are very few sites in the south and east of England.

Some basic summary statistics for the operational, non-urban wind farms in the dataset are shown in Table 1. There are 148 wind farms recorded in operation in England and Wales over this period (after eliminating some single-turbine urban and industrial sites). The mean operational wind farm has 11 turbines (6 median) with a capacity of 18.6 MW, but the distribution is highly skewed, with a maximum number of turbines of 103 and capacity of 150MW. These largest wind farms are off-shore. The average height to the tip of the turbine blades of just over 90m, though the tallest turbines (mainly offshore) reach to 150m. The distribution of wind farms across land cover types is given in the table notes and shows that most wind farms are in farmland locations, followed by mountain and moorland locations. Offshore sites are also included in the analysis, where these are potentially visible from residential areas on shore. Urban and most industrial locations (except where these impact on rural areas) are excluded from the analysis.

Table 2 summarises the main postcode-by-quarter aggregated panel data set, with information on property prices and characteristics, and the distribution of visible and non-visible operational turbines. The top panel with the housing summary statistics relates to the sample of postcodes with operational turbines within 14km in 2000, or appearing within 14km at some time over the sample period up to the end of 2011. Price dataset is merged to the wind farm dataset with a one-quarter lag, so the price series runs from the first quarter of 2000 to the first quarter of 2012. Changing the lag to 6 months made essentially no difference to the regression results presented below. To show the spatial structure of the data, the second panel shows the number of postcodes in the data at different wind farm distances, categorised according to whether the wind farms are visible (based on the modelled view-shed). Note that many postcodes have both visible and non-visible turbines over the whole period. The third panel provides information on how many of the postcodes that will have visible turbines, have sales in both pre and post operation periods. This panel also shows the mean time interval between sales in the pre and post periods. There are 1125 postcodes with visible turbines within 1km, though only 468 of these have repeat sales in pre and post periods. Wind farms are visible from nearly all these postcodes. As we move further out, the number of postcodes increases to over 220000 and the proportion from which turbines become visible decreases to around 56% within 14km band. At greater distances it becomes more likely that views from the postcode neighbourhood are obscured by intervening terrain. The mean interval between sales in the pre and post operation periods is stable over all distances at around 23 quarters (5.75 years), implying that the regression estimates that follow will represent the average price change occurring over this time interval. Overall there around 7.75 repeat observations for each postcode (=1710293/220669 from the numbers in the table). The median number of transactions (not reported in the table) per postcode-quarter cell is 1 with a median of 1 and a 99th percentile of 5.

The methods described in 4.2 proposed comparing the price effects in postcodes with visible-operational turbines to the price effects in postcodes with non-visible operational turbines. To illustrate the basis for this approach, Figure 3 shows the viewshed for a wind farm in north east

England. This is the Haswell Moor wind farm in County Durham, which has 5 turbines, a total capacity of 10MW and the height to the tip of the turbines is 110m. This is a fairly typical wind farm development in the sample. The dark shaded areas are residential postcodes and the light grey shading indicates the land where at least the tips of the turbine blades are visible (technically, these are computed as the land surface that is visible to an observer at the tip of the turbine). Results presented in the next section compare prices changes occurring with the start of wind farm operation in these postcodes where the turbines are visible, with those occurring where they are not-visible.

5.2 Baseline regression results on visibility and robustness tests

Table 3 reports the coefficients from a baseline set of postcode fixed-effects regressions of prices on wind farm proximity and visibility indicators discussed in Sections 4.1 and 4.2, using separate regressions for different radii, from 1 to 14km. For each radius, the first two columns restrict the sample to postcodes which have or will have an operational wind farm within the specified distance following the approach of Section 4.1. Identification comes purely from comparing the change in mean postcode-quarter specific prices between the periods before and after the wind farm operation, with the changes occurring in postcodes that have already got visible-operational wind farms or which will do so in the future. For radii above 1km, the third column at each radius extends the sample to include postcodes which have or will have non-visible operational wind farms within the specified distance following the approach of Section 4.2 (this is infeasible at 1km since almost all postcodes have wind farms visible). The regression in the first column of each set has no control variables other than quarterly dummy variables. Other columns control for the property characteristics and the array of geographical trends described in the methods section. Standard errors are clustered at Census Output Area level (10 or so postcodes) to allow for serial correlation in the errors over time and spatial correlation in the price changes across neighbouring postcodes.

The key finding from this table is that prices in postcodes where wind farms are close and visible are reduced quite substantially over the period in which a wind farm becomes operational. The price impact is around 6.5% within 1km, falling to 5.5-6% within 2km, 2.5-3% within 4km. Beyond 4 km the effect falls below 1% and becomes statistically insignificant, at least once control variables are included. Generally, controlling for property characteristics and the array of terrain-by year dummies makes little difference to the results, suggesting that unobserved price trends or changes in the types of housing being sold do not affect the results substantively.

Columns 5, 8, 11 and 14 include indicators of proximate non-visible wind farms, and tell us more about the specific visibility impacts of wind farms, as distinct from other costs and benefits associated with their operation. The point estimates within the 2km band are similar to those for visible-operational turbines, but statistically insignificant, given that the small share of postcodes with non-visible wind farms within 2km (5% from Table 2). In part, the coefficient on non-visible wind farms within 2km may be picking up impacts on the few sales much closer to wind farms, where turbines are not visible but noise may be an issue (the estimates later on in Table 6 present the impacts in distance bands to address this issue). Further out, a more interesting pattern emerges. Within 4km (where wind farms are hidden for 18% of postcodes) there is no effect on prices from non-visible operational turbines, while visible wind farms reduce prices by 2.4%. This comparison suggests that the negative effects from visible-operational turbines are specifically attributable to visibility. Within 8km, there are signs of some up-lift of around 1.6% for prices in postcodes where wind farms become operational, but are hidden, and the effect of visible turbines falls to zero. Given there was no detectable effect from non-visible wind farms within 4km, the uplift in prices is evidently within the 4-8km band (as shown in subsequent results). There are a number of possible interpretations of this price premium. Firstly there could be spurious effects due to non-random placement of wind farms although it seems unlikely that this this would show up specifically for non-visible wind farms at this radius. Secondly, there may be benefits to home owners within the 8km radius, offset by other costs at closer distances. Lastly, prices may be increased by displacement of demand from neighbouring areas where the turbines are visible. These displacement price effects are theoretically possible if buyers in these rural housing markets are relatively constrained in their choices (e.g. by family, jobs, search costs, other local amenities) and willing to pay more for housing in these localities without wind farm visibility rather than seek alternative housing in completely different non-wind farm locations. It is not possible to distinguish between these second and third hypotheses, but either way, the results for non-visible wind farms are reassuring in showing that the *negative* impacts from visible wind farms do not arise from a spurious association between price trends and the timing and location of wind farm development. Again, overall within the 14km, the regressions indicate no positive or negative effects associated with the timing of wind farm operations in the general local area.

All this evidence suggests that the estimated price reductions in postcodes where wind farms are visible are causally attributable to wind farm visibility. Later results will provide more detail on the pattern of distance decay of the wind farm price effects, and present some more formal difference-in-difference-in-difference estimates of the visibility impacts.

One concern could be that the price effects by distance and visibility status are the result of general spatial price trends, generated by other factors such as housing supply or opportunities in the labour market. Although the patterns in Table 3 are consistent with what we might expect theoretically from a causal effect of wind farms on prices, it is potentially possible that windfarms just happen to always be opening in regions where prices are falling, relative to regions where windfarms already exist, and falling more in places close to new windfarms than in places further away. Since the sample is restricted to sales close to windfarms, and does not include any sales in the wider region beyond 14km from wind farms sites, there are limits to how flexibly the specifications can control for very general regional trends. However, Appendix Table 8 demonstrates that the patterns are similar after controlling for regional price trends, which are defined by splitting the sample (sales <14km from a windfarm) into four north, south, east and west quadrants and interacting quadrant indicators with year dummies. In this specification, comparison is being made between sales around wind farms opening in one location, and windfarms that exist or will exist in the same quadrant of England and Wales.

Table 4 and Table 5 present further assessments of the credibility of the findings by checking for spurious price trends and changes in the types of housing being sold as the wind farms become operational. The results shown are for the sample within the 4km radius, but the general picture is the same when the exercise is repeated at other distances. Table 4 presents a series of 'balancing' tests in which the dependent variable in the regressions of Table 3, column 8, is replaced by housing characteristics, and the housing characteristics are excluded from the set of regressors. The aim here is to see if there are within-postcode changes in the composition of the sample that coincide with the start of wind farm operations. Columns 1-6 use the few characteristics that are available in the Land Registry data set as the dependent variables. In column 7 the dependent variable in postcode quarter i,t is the cumulative sum of sales in postcode i up to period t and the regression provides a test for changes in the rate of transactions between the before and after operation periods. In the remaining columns, the dependent variables are postcode-by-year mean characteristics taken from an auxiliary dataset of transactions from the Nationwide building society and merged to the dataset. This dataset has far more information on housing characteristics, but is only a sub-set of transactions, and hence postcodes, in the Land Registry data, therefore the sample size is much reduced. Looking across Table 4 it is evident that there are no statistically significant changes in the composition of housing transactions associated with wind farm operation, and there is no systematic pattern in the point estimates that would suggest that the price changes in Table 3 could be related to the sale of lower quality houses.

Table 5 carries out further robustness tests on the 4km sample, firstly adding in the Nationwide data set characteristics as control variables (column 2), and replacing the Land Registry prices with prices from the Nationwide (column 3). The coefficient estimates from the Nationwide sample are slightly larger than those from the Land Registry, although not by much relative to the standard errors, and changing the source of the price information does not make any difference. Column 4 adds in additional demographic characteristics from the 2001 Census (proportion not qualified, proportion tertiary qualified, proportion born in UK, proportion white ethnicity, proportion employed, proportion in social rented accommodation) interacted with linear time trend, but again this has no bearing on the results.

Column 5 shows a specification which controls for region-specific quarterly price index, based on prices in the ten standard regions of England and Wales. As noted above, it is not feasible to do this simply by including region-by-quarter dummies, because there are too few wind farms becoming operational in any region-quarter period. Instead, the region-quarter price indices are estimated a first stage postcode-fixed effects regression of log prices on region-quarter dummies in the full Land Registry price paid dataset[9]. The estimated region-quarter effects are then used as controls in the second stage estimation. Again this has no impact on the key result, even though

[9] The sample is restricted to postcodes *beyond* the 14km wind-farm distance limit, otherwise the estimated price index would be mechanically endogenous in the price regressions based on the wind farm sample.

the region-quarter effects are strongly correlated with the prices close to the wind farms (the coefficient on the region-quarter effects is 1.059, with a standard error of 0.030).

Column 6 does something similar, but controlling for predicted pre-operational and post-operational linear price trends in the area defined by the set of postcodes that share the same nearest operational wind farm within 4km. Again it is not practical to simply include nearest-wind-farm specific trend variables, since the price changes in response to wind-farm operation are not sharp enough to successfully identify these separately from wind-farm specific price trends over the whole period. Instead, similarly to the region-quarter trends, the pre-operation and post-operation wind farm price trends are estimated in a first stage regression of prices wind farm-specific time trends using observations for the pre-operation or post-operation period only. The first stage regression predictions of the wind farms specific price trends from the pre-operation period are then extrapolated over the whole sample period and included as controls in the second stage regression. Controlling for pre and post operation price trends in this way yields a slightly bigger coefficient on visible wind farms, suggesting that the baseline estimates in Table 3 are, if anything, conservative. This is consistent with post-announcement, pre operation downward price trends, which will reduce the pre-post operation average price difference and attenuate the basic within-groups fixed effects estimates of Table 3.

Column 8 and 9 also test for robustness to other regional price drivers. Column 8 controls for differences in new housing supply across space. Highly geographically detailed data on housing supply is not available in England or Wales, but Column 8 uses the best information available and controls the number of housing construction starts (in logs) in each of the ten standard Regions in England and Wales in each year. Column 9 includes labour market variables, namely mean wages and jobs per capita at the Local Authority, County or Region level (there are 348 Local Authorities, and 42 Counties in England and Wales).[10]

Many windfarms are close to the coastline of England and Wales, so there is an outside chance that the results could be influenced by coastline visibility, given that coastline visibility is presumably a desirable amenity. To check this, Column 9 controls for trends associated with coastal views. A coastal view-shed was constructed for places within 14km of the coastline, and sales categorised in quintiles of coast line visibility. The specification in Column 9 includes and interaction of top quintile coastline visibility with year dummies. Evidently, differences in coast views do not explain the estimated effects of wind farms on prices, although the unreported coefficients on the coast-view-by-year dummies indicate differential trends in coastal locations.

Overall, there is no evidence from Table 4 and Table 5 that the finding of negative impacts from wind farms on prices arises from omitted variables or unobserved price trends.

More detail on distance-decay of the wind farm price effects and the differences in the effects of visible and non-visible wind farms within the 14km limit is provided in Table 6. In this specification, estimation is from postcodes with transactions within 14km of a site, and treatment indicators for the different distance bands are included in a single regression. The coefficients indicate the effects at each distance band within this 14km radius. The estimation includes postcodes with or without wind farm visibility. The results are broadly in line with the alternative presentation in Table 3, but there are some subtle differences. These differences arise because the coefficients on the housing control variables, quarter dummies and terrain-by-year trends are estimated from the full 14km radius sample. This specification also constrains postcodes within

[10] In the vast majority of cases Local Authority variables are used, but these are not always published for Local Authorities due to small sample sizes, in which case higher level geography is used.

each wind-farm distance band to be on the same general price trend in the absence of any effects due to wind farm operation and visibility (through distance-band-by-year interations). At the same time the specification allows for differences in general price trends between postcodes with potential wind farm visibility and those without for the whole 14km radius circle (through visibility-by-quarter interactions).

Looking at Table 6, the price effect for visible turbines within 1km, and at 1-2km is around 5.5-6%. This falls quite sharply in the 2-4km distance band, to just under 2%. Beyond this there are price effects from visible turbines right out as far as 14km, although these are small at around 0.5-1%. The results in the next section show that these effects at greater distances are associated with the largest wind farms only. In contrast, the coefficients on non-visible turbines are generally positive, but small and non-significant except in the 4-8km band. Note that the coefficients on non-visible turbines look comparable in magnitude but opposite in sign to the effects of visible turbines in the 4-8km band, which might suggest some aggregate net gains in terms of total housing values. However, it should be borne in mind that only 35% of postcodes within 8km of a wind farm do not have views of the wind farms, so a much smaller share of transactions see price gains rather than price losses. The impacts of wind farms 8-14km away, where the wind farms are not visible, is, as expected, zero and insignificant.

Potential theoretical reasons for these positive effects associated with proximity to turbines where the turbines are hidden were discussed in relation to Table 3. A corollary is that the coefficients on the wind farm visibility indicators, while showing the house price changes, underestimate the value of the visual dis-amenity of wind farms. As discussed in Section 4.2 a difference-in-difference-in-difference estimate based on the difference between the coefficients on visible turbines and non-visible turbines at each distance band provides a cleaner estimate of the willingness to pay to avoid views of wind farms. These estimates are shown in the bottom panel of Table 6. These are calculated from the coefficients and the variance-covariance matrix of the coefficients in Table 6. Given the small positive coefficients associated with non-visible wind farms, the basic price effects estimated from the visible-operational treatment dummies under-estimate the marginal willingness to pay to avoid the visual dis-amenity and the difference-in-difference-in-difference estimates are slightly larger in magnitude. Within 2km, the visual impact of wind farms is has an implied cost of around 8.5% of housing prices, between 2km and 8km the figure falls to around 3.5%, whilst beyond 8km there is virtually no impact (just under 0.7%).

5.3 *Further results on wind farm size.*

The results so far have looked simply at turbine development as a binary treatment effect, and have ignored the scale of the wind farm. Table 7 provides a more comprehensive analysis that investigates whether there is a greater cost associated with larger developments with more turbines, and over what distance. The setup is basically the same as in Table 6, but with interactions between dummies for wind farm size and distance. Again, the lower panel of the table reports difference-in-difference-in-difference estimates of the price differentials associated with visibility for each distance band and wind farm size group. Figure 4 illustrates the patterns in Table 7 by plotting the coefficients against the mid points of the distance bands. The results are in line with what would be expected if the price impacts are related to the dis-amenity of wind farm visibility. Bigger wind farms have a bigger impact on prices at all distances. A wind farm with 20+ turbines within 2km reduces prices by some 12% on average, and the implied effect of the visual dis-amenity is around 15%. Note though that there is a relatively small number of transactions within 2km of the centroid of a 20+ turbine wind farm (988) and given the geographical spread of the turbine array, this price effect could also relate to noise and visual flicker problems. However, even at 8-14km there is a 4.5% reduction in prices associated with large visible operational wind farms, and the willingness to pay to avoid visibility is 6.5%. Even at 8km there is some negative impact of the large wind farms, and all of this is attributable to visibility. Medium size wind farms above average size also have strong effects throughout the distance range up to 8km, but no effect after that. The effect of smaller wind farms with less than 1-10 turbines is, as might be expected, concentrated in the first 2km where there is a 5% reduction in prices. This falls to just over 1.5% at 4km and becomes zero and insignificant beyond that, although there is an implied visibility cost in the 4-8km range due to the lift in prices of houses in the 4-8km range where turbines are not visible. All in all, the results in Table 7 and their visualisation in Figure 4 are entirely consistent with theoretical reasoning about the potential visual impacts of wind farms, and the differences across wind farm size and distance band provide reassurance that the effects are genuinely causal and not spurious.

One concern in any spatial estimation design with multiple interventions on grouped observation (wind farm developments affecting groups of neighbouring houses in this case) is the estimation of the standard errors (Moulton 1990, Conley and Taber 2011). All specifications so far allowed for serial and spatial correlation (and heteroscedasticity) in unobservable factors within neighbouring groups of postcodes defined by Census Output Areas, using clustered standard errors at this level. These standard errors may be biased by more general spatial autocorrelation in the unobservables, between Census Output Area groups. Tests on the regression residuals fail to find evidence of this spatial autocorrelation. Moran's I statistics based on the residuals have values of less than 0.001 (on a theoretical range of -1/+1), and the p-value for the test of the null of no spatial autocorrelation is 0.5 or higher. [11] Nevertheless, some alternative standard errors allowing for more general spatial

[11] Moran's I statistics are estimates of Cov(m(x), x)/(Var(x)) where m(x) is an average of x over neighbouring observations and neighbours are defined by spatial weights. Tests were performed using inverse distance weights, and average of observations within 4km.

autocorrelation are shown for the final specification in Appendix Table A1. Standard errors using the double clustering method of Thompson (2011), allowing for serial correlation within postcodes, and cross sectional correlation within quarters, are similar to those obtained from clustering at Census OA level. Standard errors with clustering on Census Wards yields larger standard errors and lower levels of significance, although the pattern remains the same, with statistically significant coefficients for small wind farms up to 4km, and statistically significant impacts from large wind farms throughout the distance range. Standard errors clustered on nearest wind farm groups (not reported) yield similar results to the ward-based clustered standard errors.

6 Conclusions

The analysis in this paper provided estimates of the effects of wind farm visibility on housing prices in England and Wales. The fairly crowded geographical setting, with numerous wind farms developed within sight of residential property, provides a unique opportunity to examine the visual impacts of wind farms through hedonic property value methods. The analysis used a micro-aggregated postcode-by-quarter panel of housing transactions spanning 12 years, and estimated difference-in-difference effects using a quasi-experimental, postcode fixed effects methodology. Comparisons were made between house price changes occurring in postcodes where nearby wind farms become operational and visible, with the price changes occurring where nearby wind farms become operational but are hidden from view. All the results point in the same direction. Wind farms reduce house prices in postcodes where the turbines are visible, and reduce prices relative to postcodes close to wind farms where the wind farms are not visible. Averaging over wind farms of all sizes, this price reduction is around 5-6% within 2km, falling to less than 2% between 2 and 4km, and less than 1% by 14km which is at the limit of likely visibility. As might be expected, small wind farms have no impact beyond 4km, whereas the largest wind farms (20+ turbines) reduce prices by 12% within 2km, and reduce prices by small amounts right out to 14k (by around 1.5%).

There are small (~2%) increases in neighbouring prices where the wind farms are not visible, although these are only statistically significant in the 4-8km band. This price uplift may indicate some local benefits from wind farms, for example due to spillovers from rents to landowners from wind farm operation, or from community grants. However these price increases could also be explained by displacement of demand by those seeking housing in these areas towards places where the wind farms are hidden. These offsetting price effects in neighbouring places where wind farms are visible and where they are not may explain, in part, why previous studies that focus only on distance to wind farms fail to find significant effects.

These headline findings are comparable to the effects of coal power plants in the US found in Davis (2011) who finds up to 7% reduction within 2 miles (3.2 km). Of course, it takes many geographically dispersed wind farms to generate the same power as a single coal (or nuclear) plant, so the aggregate effects of wind farms and the number of households affected by their visual impact is likely to be considerably larger. The results are also in line with existing literature that suggests that other tall power infrastructure has negative impacts on prices (e.g. high voltage power lines, Sims and Dent 2005). The point estimates are comparable to the repeat sales estimates of the effects of wind farms in in Lang et al (2014) for Rhode Island, although their estimates are not statistically significant.

The paper presents a number of robustness tests, but even so the findings should be interpreted with some caution. The information on wind farm location and visibility is limited by lack of data on the precise location of individual turbines, so the classification of postcodes in terms of visibility is subject to measurement error. This is most likely to result in some attenuation of the estimated effects. Steps were taken to minimise this problem by eliminating postcodes where visibility is ambiguous. More importantly, there is no historical information on the timing of events leading up to wind farm operation (announcement, approval, construction etc.) so the price effects reported here relate to the average difference between the post-operation and pre-operation periods for the periods spanned by the data (a gap of just under 6 years). However, the wind farm development cycle can last a number of years, and price changes evolve fairly slowly over time in response to events. Again the most likely consequence of this is that the results underestimate the full impact between the pre-announcement and post-construction phase. It should also be noted that the estimates of turbine visibility, may pick up some effects from turbine noise – especially close to large windfarms, if terrain that hides the windfarms also attenuates the noise. However, noise levels at the distances beyond 1km at which the visible/non-visible comparisons are made are likely to be very low.

Well established theories (Rosen 1974) suggest that we can interpret price differentials emerging between places where wind farms are visible and comparable places where they are not, as household marginal willingness to pay to avoid the dis-amenity associated with wind farm visibility (though Kuminoff and Pope, 2014, has recently highlighted some potential pitfalls in interpreting difference-in-difference estimates in this way). If we take the figures in the current paper seriously as estimates of the mean willingness to pay to avoid wind farms in communities exposed to their development, the implied costs are quite substantial. For example, a household would be willing to pay around £600 per year to avoid having a wind farm of small-average size visible within 2km, around £1000 to avoid a large wind farm visible at that distance and around £125 per year to avoid having a large wind farm visible in the 8-14km range.[12] The implied amounts required per wind farm to compensate households for their loss of visual amenities is

[12] These figures is based on an average house price of £145,000 (in 2010), a the visible-non-visible price differentials from Table 7 and a 5% interest rate.

therefore fairly large: about £14 million on average to compensate households within 4km.[13] The corresponding values for large wind farms will be much higher than this, as their impact is larger and spreads out over much greater distances.

These per-household figures are somewhat higher than the highest estimates from the stated preference literature, although there are no directly comparable figures. The figures cited in Bassi, Bowen and Fankhauser (2012) are typically much less than £100 per year, though this is per individual, so household willingness to pay could be higher.

The findings of the paper are relevant on a number of policy levels. The estimates provide potential inputs into cost-benefit analyses related to the siting of wind turbines, and the net benefits of wind power relative to other forms of low carbon energy. It should be noted, however, that the price effects reflect the valuation of home buyers in locations where wind farms are visible, so may not represent the mean valuation of wind farm visibility in the general population. The estimates could also inform policy on compensation for home owners for the loss of value in their homes arising from views of new wind farms. Interestingly, the evident increase in value of for houses where local wind farms are out of site suggests some scope, at least in theory, for these 'winners' to compensate the 'losers' in places where the turbines are visible e.g. through adjusting council taxes or introducing property value taxes.

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Table 1: Operational windfarm summary data, 1992-2011 England and Wales

	Mean	s.d.	Min	Max
148 wind farms				
Turbines mean	11.2	15.4	1	103
Turbines median	6			
MW capacity	18.6	39.2	.22	300
Height to tip	90.9	29.2	42	150

Landcover of non-urban/industrial wind farms: Offshore 14; Forest 8; Farmland 82; Moorland and mountain 39; Coastal 5.

Table 2: Main estimation sample summary data, 2000-2011 England and Wales

	Mean	s.d.	Obs
Sales in postcodes operational turbine at some time 2000-2011 within 14km			
Log price	11.56	0.674	1710293
New build	0.041	0.192	1710293
Detached house	0.250	0.423	1710293
Semi-detached house	0.070	0.249	1710293
Terraced house	0.320	0.452	1710293
Flat/Maisonette	0.361	0.469	1710293
Freehold	0.849	0.351	1710293
Postcodes within 1km of wind farm, 2000-2011			1142
Where visible			1125
Postcodes within 2km of wind farm, 2000-2011			5350
Where visible			5062
Postcodes within 4km of wind farm, 2000-2011			20838
Where visible			17031
Postcodes within 8km of wind farm, 2000-2011			81820
Where visible			52980
Postcodes within 14km of wind farm, 2000-2011			220669
Where visible			123892
Time between post-pre sales in same postcode (quarters)			
Visible within 1km	23.335	5.016	468
Visible within 2km	23.379	6.189	2004
Visible within 4km	23.297	6.170	7348
Visible within 8km	23.047	6.150	24408
Visible within 14km	23.148	6.131	59852

Table 3: Postcode fixed effects estimates; samples with operational wind farm within k km, during 2000-2011

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Radius	<1km	<1km	<2km	<2km	<2km	<4km	<4km	<4km	<8km	<8km	<8km	<14km	<14km	<14km
Control vars.	No	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Visible-	-0.0632***	-0.0666**	-0.0628***	-0.0554***	-0.0558***	-0.0300***	-0.0267***	-0.0244***	-0.0144***	-0.0046	-0.0035	-0.0048*	-0.0018	-0.0027
operational:	(0.0171)	(0.0221)	(0.0095)	(0.0095)	(0.0095)	(0.0057)	(0.0055)	(0.0054)	(0.0032)	(0.0029)	(0.0029)	(0.0019)	(0.0018)	(0.0017)
Non-visible-					-0.0611			-0.0018			0.0165***			-0.0024
operational:					(0.0609)			(0.0125)			(0.0041)			(0.0020)
Obs	8,052	8,052	36,298	36,298	37,998	125,619	125,619	150,907	417,108	417,107	621,395	984,294	984,292	1,710,293
R-squared	0.8141	0.8459	0.8284	0.8580	0.8601	0.8377	0.8626	0.8642	0.8487	0.8719	0.8736	0.8461	0.8706	0.8718

Robust standard errors in parentheses, clustered at Census OA *** p<0.001, ** p<0.01, * p<0.05
Data in postcode-quarter cells, 2000-2011. Dependent variable is postcode-quarter-mean log prices.
Visible-operational is the treatment indicator (visible, 0<distance<k, operational) described in Section 4, indicating that a postcode has an operational windfarm visible within the specified radius k.
Non-visible operational is the treatment indicator (non-visible, 0<distance<k, operational) described in Section 4, indicating that a postcode has an operational windfarm within the specified radius k, but this is not likely to be visible.
Sample restricted to postcodes with visible-operational turbines within distance k at some time over the study period in columns 1,2,3,4,6,7,9,10,12,13.
Sample restricted to postcodes with visible-operational or non-visible-operational turbines within distance k at some time over the study period in columns 1,2,3,4,6,7,9,10,12,13.
Control variables in columns 1,2,3,4,6,7,9,10,12,13 are postcode slope-by-year, elevation-by-year, aspect by-year dummies, proportions of sales of detached, semi-detached, terraced, flat/maisonette.
Control variables in columns 5,8,11,14 are postcode slope-by-year, elevation-by-year, aspect by-year dummies, proportions of sales of detached, semi-detached, terraced, flat/maisonette, plus dummy groups for distance-band-by-year, and visible/non-visible-by-quarter trends.
All regressions control for quarter dummies.

Table 4: Balancing tests for various housing characteristics. 4km radius

	(1) New	(2) Detached	(3) Semi	(4) Terraced	(5) Flat	(6) Leasehold	(7) Yrly. Sales	(8) Floor area	(9) Beds	(11) Baths
Visible-	-0.0036	0.0011	-0.0001	-0.0071	0.0061	0.0039	0.0050	-0.1267	-0.0636	0.0509
operational:	(0.0059)	(0.0038)	(0.0016)	(0.0044)	(0.0038)	(0.0021)	(0.0074)	(2.0573)	(0.0464)	(0.0450)
Non-visible-	-0.0043	-0.0128	-0.0043	0.0099	0.0072	-0.0080	0.0005	0.4270	0.0193	-0.0705
operational:	(0.0069)	(0.0078)	(0.0038)	(0.0094)	(0.0090)	(0.0052)	(0.0157)	(4.9602)	(0.1198)	(0.1018)
Number of observations	150,907	150,907	150,907	150,907	150,907	150,907	150,907	17,931	17,931	17,931

	(11) No CH	(12) No Gar	(13) Detached	(14) Semi	(15) Terraced	(16) PB Flat	(17) Conv Fl	(18) Other	(19) Age
Visible-	-0.0105	-0.0178	-0.0287	0.0207	-0.0004	0.0108	0.0014	-0.0038	-0.5586
operational:	(0.0154)	(0.0304)	(0.0235)	(0.0282)	(0.0242)	(0.0150)	(0.0092)	(0.0051)	(1.7077)
Non-visible-	-0.0838	0.0212	0.0324	-0.0575	-0.0330	0.0423	0.0109	0.0048	-0.2947
operational:	(0.0612)	(0.0780)	(0.0943)	(0.1090)	(0.0733)	(0.0364)	(0.0203)	(0.0060)	(4.6216)
Number of observations	17,212	17,931	17,931	17,931	17,931	17,931	17,931	17,931	17,931

Specifications as in Table 3, column 8, but with property type control variables excluded.
Columns 8-19 based on sub-sample with transactions from Nationwide sales database.
Table reports coefficients, standard errors (clustered on OA) and sample size

Table 5: Robustness to additional control variables and trends. 4km radius

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Baseline estimate from Table 3	Sub-sample with additional Nationwide property Xs	Nationwide prices and Xs	Census output area Xs x trends	Control for regional price index from full dataset	Windfarm specific pre and post trends	Control for regional house construction starts	Control for Local Authority wages and jobs per capita	Control for coast view-by-year dummies
Visible-	-0.0244***	-0.0452**	-0.0419***	-0.0260***	-0.0206***	-0.0326***	-0.0232***	-0.0194***	-0.0263***
operational:	(0.0054)	(0.0146)	(0.0120)	(0.0054)	(0.0048)	-0.0054	(0.0054)	(0.0053)	(0.0054)
Non-visible-	-0.0018	0.0220	0.0298	-0.0123	0.0049	-0.0016	0.0105	0.0170	0.0119
operational:	(0.0125)	(0.0608)	(0.0356)	(0.0133)	(0.0114)	-0.0122	(0.0120)	(0.0120)	(0.0122)
Observations	150,907	17,212	17,212	136,031	150,907	150,907	150,907	150,907	150,907

Robust standard errors in parentheses, clustered at Census OA *** p<0.001, ** p<0.01, * p<0.05
Column 2 controls for floor size, number of bedrooms, bathrooms, central heating type, garage type, and detailed property type for postcodes represented in Nationwide data. Column 3 similar, using price reported in Nationwide data. Column 3 adds linear trends interacted with census 2001 variables at output area (OA) level (OA land area, proportion with no qualifications, proportion with tertiary qualifications, proportion born UK, proportion white ethnicity, proportion employed, proportion in social rented housing).
Column 5 controls for piecewise constant quarterly price index estimated from transactions beyond 14km from any operational windfarm.
Column 6 controls for nearest operational windfarm linear time trends estimated from pre-operational and post-operational periods.
Column 7 includes control for region-by-year private housing construction starts from Department of of Communities and Local Government housing statistics
Column 8 includes control for Local Authority-by-year wages and job density from Annual Survey of Hours and Earnings and Office for National Statistics job density data (from www.nomisweb.co.uk)
Column 9 includes coast-view by year dummies, where coast-view is an indicator that property is within 14km of the coastline and the coastline visibility is in the top 20% based on the number of coast outline vertices from which the property is visible.
Specifications otherwise as Table 3, column 8,

Table 6: Postcode fixed effects estimates; distance bands; sample with operational wind farm within 14km, during 2000-2011

	(1) <1km	(3) 1-2km	(3) 2-4km	(4) 4-8km	(5) 8-14km
Turbines visible	-0.0539***	-0.0578***	-0.0193***	-0.0104***	-0.0050**
	(0.0164)	(0.0092)	(0.0052)	(0.0028)	(0.0019)
No turbines visible	-	0.0268	0.0152	0.0223***	0.0018
		(0.0498)	(0.0105)	(0.0040)	(0.0021)
Difference-in-difference-in-difference estimates relative to non-visible					
	-	-0.0847†	-0.0345**	-0.0327***	-0.0068*
		0.0501	0.0106	0.0046	0.0027

Notes as for Table 3, column 8, but with additional wind farm distance indicator
Observations 1710293, R-squared 0.8719
Robust standard errors in parentheses, clustered at Census OA *** p<0.001, ** p<0.01, * p<0.05, † p<0.10

Table 7: Effects by windfarm size and distance bands

	(1) <2km	(2) 2-4km	(3) 4-8km	(4) 8-14km
No turbines visible	0.0276	0.0154	0.0217***	0.0015
	(0.0498)	(0.0105)	(0.0040)	(0.0021)
1-10 turbines visible	-0.0556***	-0.0165**	-0.0032	-0.0023
	(0.0084)	(0.0053)	(0.0030)	(0.0021)
11-20 turbines visible	-0.0512**	-0.0213*	-0.0371***	-0.0013
	(0.0187)	(0.0091)	(0.0055)	(0.0035)
20+ turbines visible	-0.1199***	-0.0530**	-0.0466***	-0.0162***
	(0.0277)	(0.0169)	(0.0059)	(0.0029)

Obs. 1,710,293. R-squared 0.8719

	(5) <2km	(6) 2-4km	(7) 4-8km	(8) 8-14km
Difference-in-difference-in-difference estimates relative to non-visible				
1-10 turbines visible	-0.0832†	-0.0319**	-0.0249***	0.0038
	0.0501	0.0107	0.0048	0.0029
11-20 turbines visible	-0.0789	-0.0368**	-0.0588***	0.0027
	0.0527	0.0128	0.0066	0.0039
20+ turbines visible	-0.1475**	-0.0685**	-0.0684***	-0.0177***
	0.0560	0.0192	0.0069	0.0035

Notes as for Table 3, column 8, but with additional turbine size indicators
Robust standard errors in parentheses, clustered at Census OA *** p<0.001, ** p<0.01, * p<0.05, † p<0.10

Figure 1: Development of wind turbines in England and Wales, 1993-2011

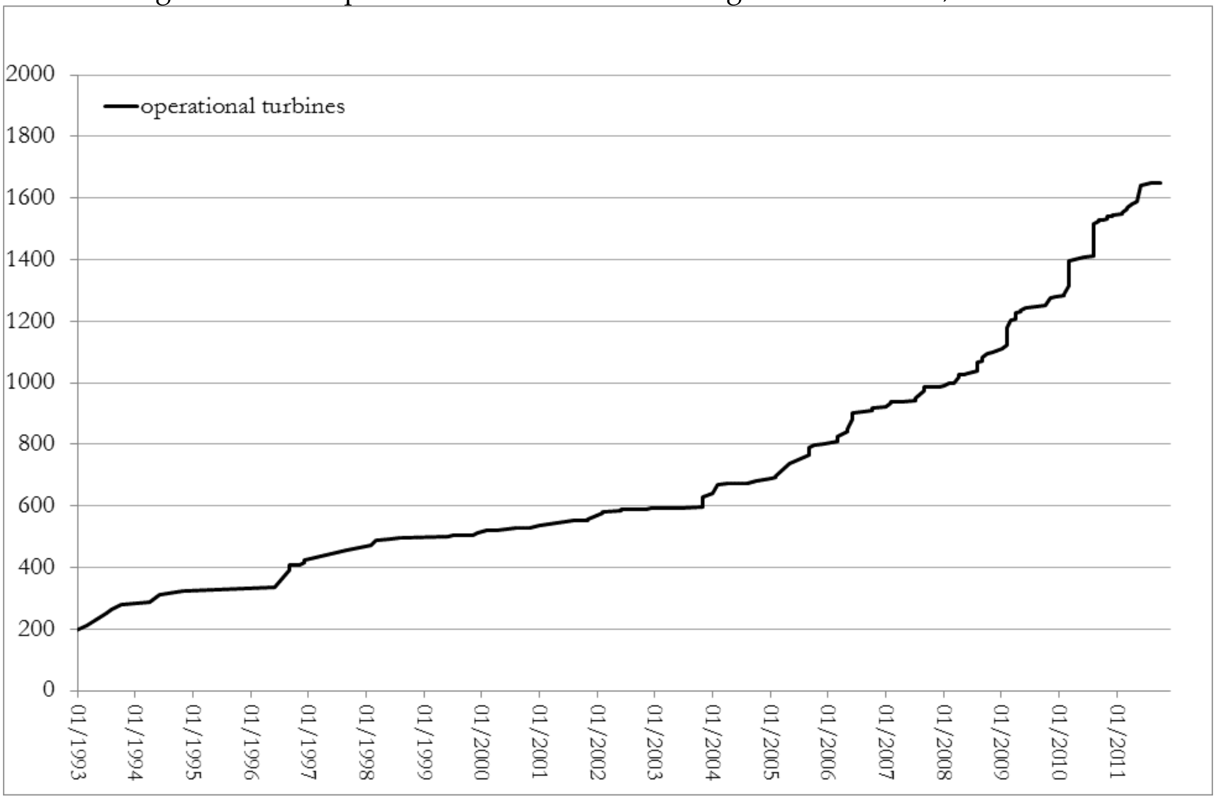
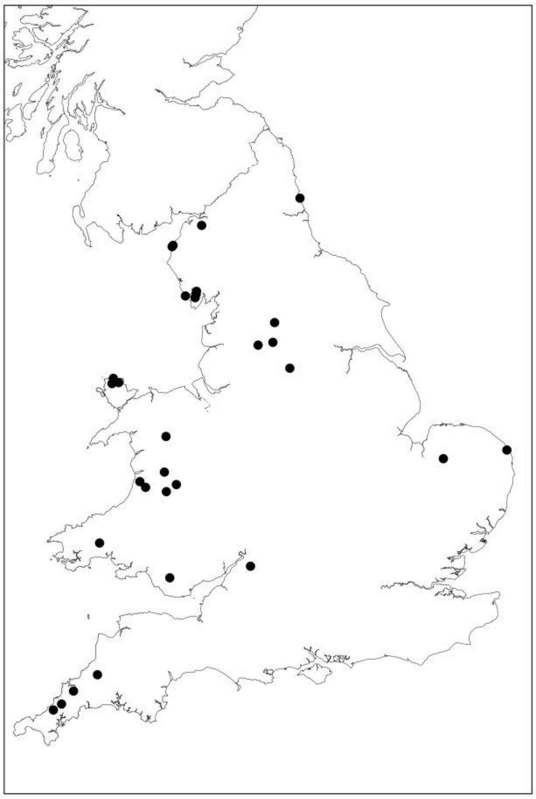


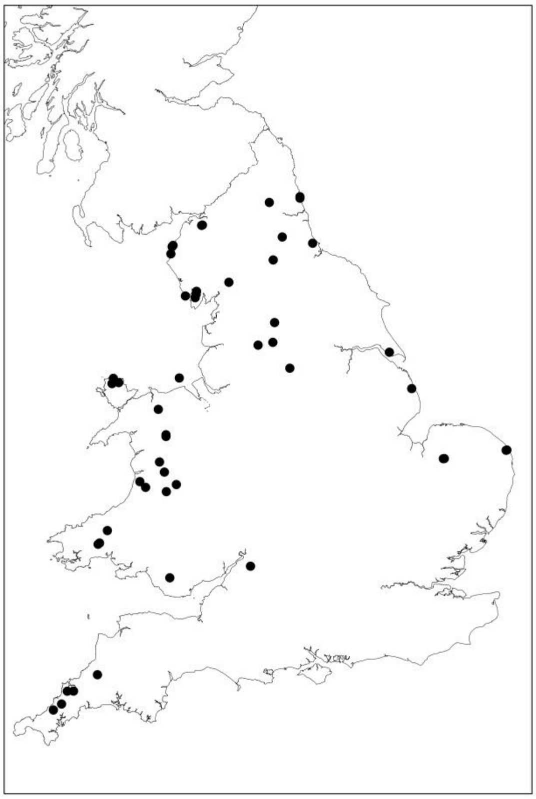
Figure includes onshore and offshore wind farms which are closer than 16km to postcodes with housing transactions

Figure 2: Development of wind turbine sites in England and Wales

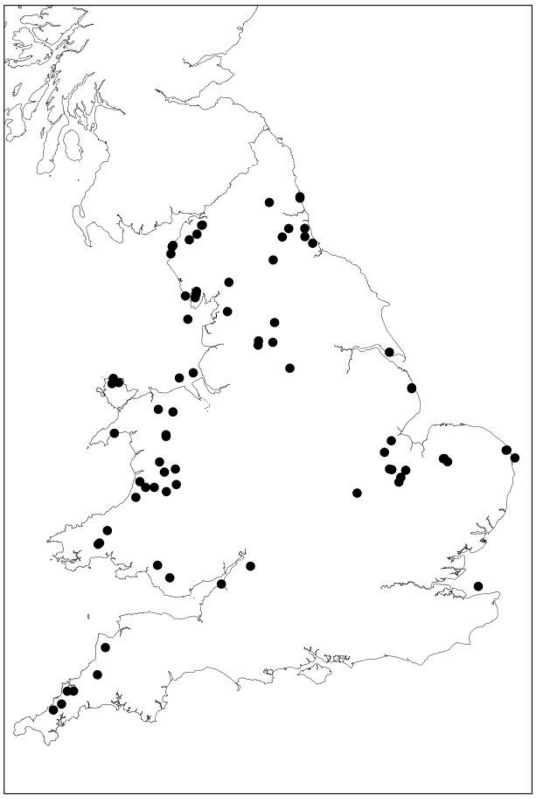
2000: 30 sites



2003: +20 sites



2007: +33 sites



2011: +65 sites

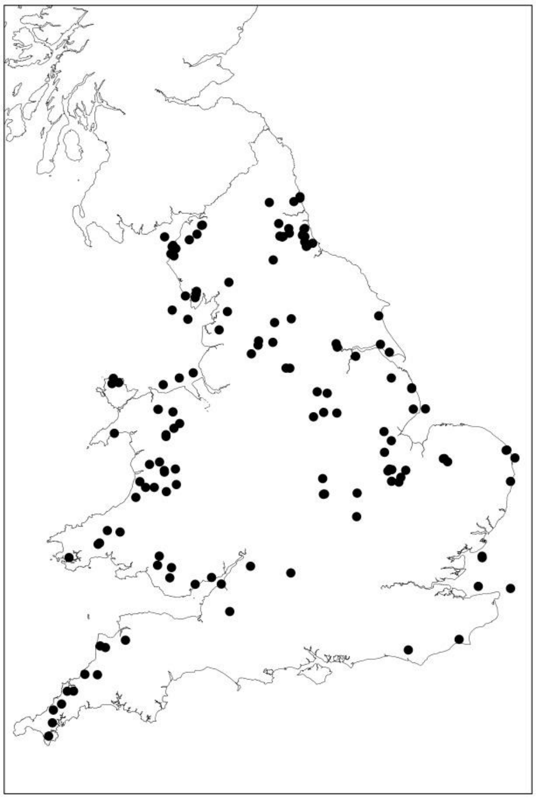
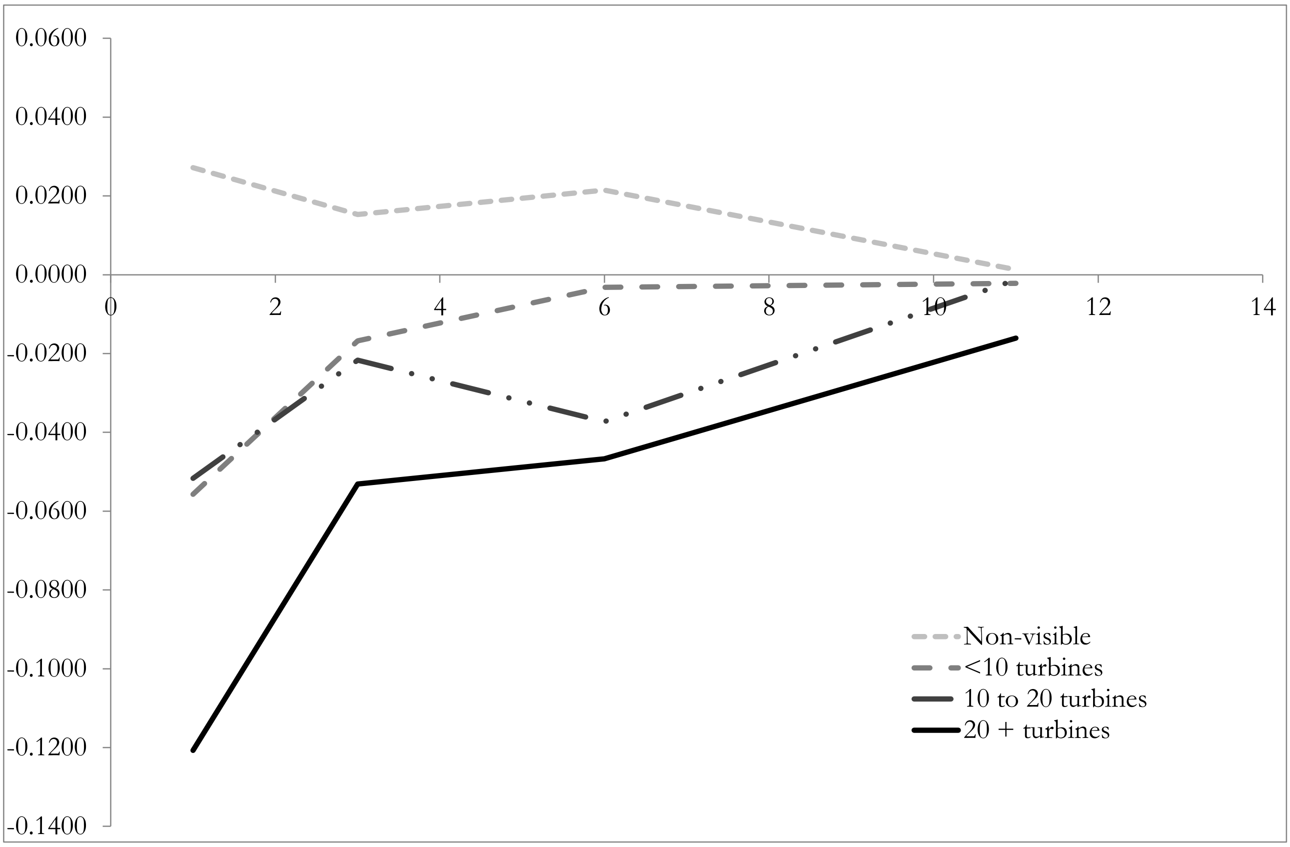


Figure 3: Example viewshed. Haswell Moor wind farm in north east England

Figure 4: Comparison by visibility: Postcode fixed effects estimates; distance bands; controls include distance-band-by-year effects and visibility-by-quarter effects.



7 Appendix

Table 8: Postcode fixed effects estimates; samples with operational wind farm within k km, during 2000-2011; additional controls for region-by-year effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Radius	<1km	<2km	<2km	<4km	<4km	<8km	<8km	<14km	<14km
Control vars.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Visible-operational:	-0.0663***	-0.0438***	-0.0455***	-0.0306***	-0.0301***	-0.0105***	-0.0089***	-0.0117***	-0.0105***
	(0.0183)	(0.0088)	(0.0088)	(0.0049)	(0.0048)	(0.0026)	(0.0026)	(0.0016)	(0.0016)
Non-visible-operational:			-0.0696		-0.0110		0.0057		-0.0074***
			(0.0595)		(0.0122)		(0.0040)		(0.0019)
Sample	Visible	Visible	All	Visible	All	Visible	All	Visible	All
Obs	8,052	36,298	37,998	125,619	150,907	417,107	621,395	984,292	1,710,293
R-squared	0.8505	0.8615	0.8632	0.8660	0.8666	0.8753	0.8756	0.8735	0.8742

Notes as in Table 3
Additional controls for regional trends: north, south, east and west quadrant-by year dummies

Table 9: Alternative standard errors: windfarm size and distance bands

	(1) <2km	(2) 2-4km	(3) 4-8km	(4) 8-14km
No turbines visible	0.0272	0.0153	0.0215*	0.0013
	(0.0498)	(0.0105)	(0.0040)	(0.0021)
	[0.0486]	[0.0121]	[0.0058]	[0.0035]
	{0.0539}	{0.0159}	{0.0084}	{0.0046}
1-10 turbines visible	-0.0557**	-0.0168†	-0.0032	-0.0022
	(0.0084)	(0.0053)	(0.0030)	(0.0021)
	[0.0084]	[0.0053]	[0.0047]	[0.0033]
	{0.017}	{0.0101}	{0.0069}	{0.0052}
11-20 turbines visible	-0.0517†	-0.0217	-0.0373**	-0.0013
	(0.0187)	(0.0091)	(0.0055)	(0.0035)
	[0.0253]	[0.0102]	[0.0083]	[0.0052]
	{0.0269}	{0.0141}	{0.0127}	{0.0073}
20+ turbines visible	-0.1207***	-0.0531†	-0.0467***	-0.0161*
	(0.0275)	(0.0169)	(0.0059)	(0.0029)
	[0.0287]	[0.0140]	[0.0073]	[0.0036]
	{0.0201}	{0.0290}	{0.0115}	{0.0067}

Obs. 1,710,293. R-squared 0.8718

Notes as for Table 3, column 8, but with additional turbine size indicators
Robust standard errors in parentheses, clustered at Census OA (.), double clustering at postcode and quarter following Thompson 2011 [.], ward {.}
Significance indicated for most conservative ward-clustered standard errors *** p<0.001, ** p<0.01, * p<0.05, † p>0.10

Wind Turbine Syndrome

A REPORT ON A NATURAL EXPERIMENT

Nina Pierpont, M.D., Ph.D.

“Wind turbines definitely lower local property values. The only question is, how much?”

Feb 12, 2014

— **Carl V Phillips PhD**, Guest Editor

Large wind generators (IWTs, for “industrial wind turbines”) cause health problems for nearby residents, kill birds, and destabilize the power grid. Something those impacts have in common is that it would be *possible* for them to not be the case, and so attempts to deny them represent merely a refusal to acknowledge the overwhelming empirical evidence. That “merely” contrasts with another impact, IWTs lowering local residential property values. Denial of that not only requires ignoring the specific empirical evidence, but requires a suspension of well-established principles of economics.

The value of a piece of real estate is what someone is willing to pay for it. More specifically, in a theoretical perfect market, it is what the person (or family or other entity) who values it second-most would pay for it. This is because whoever values it first-most would have to pay $1 more than that value in order to win the bidding for it. Anything that would cause that person in the second-most position to value the property less, therefore, lowers its value.

Many people are aware of the potential health effects of nearby IWTs, and thus will value a property enormously less if it is near IWTs. For many others, the audible noise or visual impact would lower the value somewhat. If the person who values a property second-most falls into either of these groups, the value of the property will be lower. There is no reason to believe that anyone prefers to have a nearby IWT, so there is no chance that person would like the property more and thus increase the value. (Note that this analysis does not consider the net change in the value of a property with income from IWTs that are actually on the property. For such properties there will still be a decrease in value from the proximity but might be a net increase because the income more than makes up for this.)

Moreover, even someone who does not personally worry about the health risk or find the aesthetic impacts objectionable will know that others do. Thus, he will know that the potential resale value of the property is lower, and since that contributes to the value, this will tend to push down the value for even those who do not mind living near the IWTs.

Thus, there is simply no question that IWTs lower the value of nearby property, and the only legitimate question is “how much?”, not “does it occur?” Anyone who insists that there is no reduction in value is trafficking in nonsense that is actually one step worse than the nonsense that there are no health impacts, in that it denies both the evidence and the irrefutable logic.

Of course, in reality markets do not function exactly like the theoretical simplification, but the same principle applies in the real world with only a bit of additional complication. The sale of a property does not attract the attention of everyone who might want to bid, and so the second-highest valuation is not based on every possible buyer, but only on those who are in the market at the particular time. But this changes nothing. More significantly, the market is not a perfect auction, so the highest offer (which determines the market value of the property) does not consist literally of someone outbidding the second-highest by $1, but rather some guesswork about what bid is enough to convince the seller that no better offer is available. But this offer will be no higher than the potential buyer’s value for the property, which will be lowered by the factors noted above, and the guesses about alternative offers will be pushed downward by those factors also. Thus the exact real world results may not be as predictable as the theoretical case, but the fact that there is a reduction in value is unchanged.

Finally, the person/family who values a property the most is almost always, by far, the one who is living there. This is why very few sales result from an interested buyer making an offer for a property that is not actively for sale. So when residents suffer problems from nearby IWTs that make them want to move, the market value is dramatically reduced because the bidding for the property no longer includes the person who previously placed the highest value on it. Even worse than this impact on the market value, the benefits from that piece of land to overall human happiness — because it no longer provides net benefits to those who valued it the most — is reduced even more.

Empirical studies are required to determine *how much* property values are decreased near IWTs, and that magnitude might affect policy decisions and certainly affects cost-benefit analyses. The methods for doing such studies are highly imperfect; hence, there is room to criticize the estimated magnitude.

One thing we know for sure is that any study or assertion that insists there is no impact — is wrong.

7 Comments »

Comment by sue hobart on 02/12/2014 at 8:12 pm

my property was priceless to me… then the turbine changed everything forever… Now it sits empty and sad…me too.

Comment by gail mair on 02/12/2014 at 11:59 pm

Ditto!
We are waiting for the turbine contract to expire – 13 years to go, then the turbines should be dismantled according to the agreement – but we're in Italy. A deposit was laid by that may be just enough to remove one turbine, Poggi Alti has ten. I'm hoping they'll at least be shut down for good.

Comment by Andreas Marciniak on 02/13/2014 at 12:53 am

I have returned to my Home in Waterloo South Australia after 2 years, to sell it, I spent the last three month, 4 days out of 7 getting it ready for sale that is the most I can but up with the Ill effects from the Turbines, have a sign, “for Sale”, but had NO one even rings to find out the price, seen people stop to get the phone number but no one has rang back to find out the price, and my Home is 3.5 km from the nearest Turbine, one of 37 X 3 mgw unites spread over 18 km ridge, if I ask people how far do they think the Turbines are from my place, most guess 1 km, because of the sheer size of them, all I can do is get my home ready and as soon as I have done with that I have to get out and see if a Agent can sell it on my behalf, don’t like my chances.

I do have a problem with selling it, because I know what the Turbines can do to your body and soul, but it is what I had worked for all my life and I need to make a new start some where a long way from Turbines, after Mum past a way over a year ago I had to move out of her shed and stayed with my Brother In law, and I can’t stay with him forever, so I need to sale , to make a new start.

Comment by Dawn Devlin on 02/13/2014 at 9:19 pm

The Massachusetts CEC (Clean Energy Center) funded study showing that wind turbines near homes don’t harm property values reminds me of the MA DEP health study that never examined anyone who lives near the turbines. The authors of the paper are located in California and Connecticut who have no experience as appraisers and, as far as I know, have never visited any town in Massachusetts as part of their research.

Doesn’t it make more sense to talk to appraisers and realtors in the actual communities that were impacted? The main flaw is that the study took averages and not individual homes into account. The numbers do not tell the whole story, my personal experience selling houses contradicts the study’s conclusions.

If the CEC wanted to find out what the impact was I would suggest they look at the Multiple Listing Service data as well as expired and cancelled listing comparison for homes that no one would buy. They also have to take into account properties listed by owners in the affected area. In fact, not a single property sale is cited in the study

As a Realtor in this area the value of property in areas affected by the turbines has been something I have been paying very close attention to for the past two years. I know of at least five homes that would be on the market right now because some of the residents in those homes have become ill from the turbines. They are not listed as the owners don’t feel they would be able to get fair market value, soon they may have no other options. In two years only 4 homes have sold within the affected areas even though Fairhaven has seen a rise overall in home sales. There are at least 4 homes in the affected area that have been listed by a Realtor or for sale by owner, priced at fair market value, on the market an average of 190 days. This cannot be a coincidence.

Why did the MA Clean Energy Center (your tax dollars at work, folks) spend $70,000 on this seriously flawed study? In my opinion to make this study more accurate a breakdown of sales in towns that have turbines is needed. Then to go one step further with a breakdown of homes within 1500 feet of industrial sized turbines. This would have given it at least some credibility.

The Commonwealth seems more focused on meeting the Governor's wind energy goals than investigating the facts on the ground. Enough with the dubious studies already. Let's investigate the real human suffering – both financial and physical – that these turbines cause.

Comment by Marie Stamos on 02/17/2014 at 8:44 am

As with realtors, every appraiser lives by a Code of Professional Ethics and Standards of Professional Appraisal Practice, violations of which can result in remedial or disciplinary actions.

It is obvious that MACEC and the creators of "Relationship between Wind Turbines and Residential Property Values in Massachusetts" (January 9, 2014) share no similar obligation or commitment to the "preservation of a healthful environment."

It is truly confounding to any realtor or appraiser why MACEC did not select a (or several) licensed independent appraisers to assess the property value impact to homes where industrial wind turbines were built with no regard to proximity to people or their most prized possession, their homes. Equally confounding is the MADEP/DPH's "Wind Turbine Health Impact Study: Report of Independent Expert Panel" (January 2012). Complaints dating back several years are what initiated these "studies" and yet not one victim, those being made ill or those who abandoned their homes, were included in the studies. Also to be questioned is why MADEP (WNTAG/Wind Turbine Noise Technical Advisory Group) has been charged with "possibly" revising noise policies when the noise policies in existence are not being enforced and people are suffering because of that lack of enforcement. And, MA DPU is "investigating" so-called best practices for the siting of land-based wind energy facilities when, from the Hoosac project to the Fairhaven project, we already know where they do not belong and nothing is being done to stop the offending industrial wind turbines.

I share the following, excerpted from the Realtor Code of Ethics and Standards of Practice.

> Preamble
>
> Under all is the land. Upon its wise utilization and widely allocated ownership depend the survival and growth of free institutions and of

our civilization. REALTORS® should recognize that the interests of the nation and its citizens require the highest and best use of the land and the widest distribution of land ownership. They require the creation of adequate housing, the building of functioning cities, the development of productive industries and farms, and THE PRESERVATION OF A HEALTHFUL ENVIRONMENT.

Such interests impose obligations beyond those of ordinary commerce. They impose grave social responsibility and a patriotic duty to which REALTORS® should dedicate themselves, and for which they should be diligent in preparing themselves. REALTORS®, therefore, are zealous to maintain and improve the standards of their calling and share with their fellow REALTORS® a common responsibility for its integrity and honor.

Comment by Bruce on 05/26/2014 at 12:30 pm

I have a friend in Mills County, Texas, home to one of the newest wind farms. He does closings for property sales. He couldn't tell me how much values have gone down within view of a wind turbine because there are no sales. When someone from a city like Austin calls a realtor and asks about rural property they always ask if there is a wind turbine in sight. If there is they say good-bye and look elsewhere. NO-SALE.

Comment by Bruce on 06/02/2014 at 3:09 pm

Several years ago I was looking for rural property in Central Texas and thought I had found the right place until I visited the property. On the adjacent property and in the western view was a very large transmission line. I said no thanks. So with one less buyer in the market for the property there is less competition and I would assume a lower selling price. Did others feel as I did? I don't know but at least one less buyer is a fact.

The comments are closed.