

# The effect of wind farms on house prices

March 2014

Strictly private and confidential

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# Executive summary: Scope

The purpose of this study is to examine whether wind farms have an effect on the value of residential properties within a 5km radius of the site. This is accomplished in two parts:

## Part 1: Presentation of raw house price data

We discuss and analyse the actual house price growth recorded based on transactions completed within a 5km radius for seven wind farm sites. In each case, we compare house prices changes in the immediate vicinity of the wind farm with those in the wider county area, from 1 January 1995 to mid-2013, using Land Registry figures.

Therefore, in Part 1 we attempt to answer the following question: **What are the observed changes in house prices within 5km of the wind farm and the wider county level through the milestones associated with development of the site (planning, construction and completion)?**

## Part 2: Econometric tests

Cebr go beyond the descriptive analysis and undertake statistical tests to ascertain whether the wind farm installation had an isolated and statistically significant impact on house prices by stripping out other factors such as the cyclical rise and fall (“boom and bust”) within in the economic cycle. These tests are undertaken by establishing whether the wind farm installation causes a statistically significant impact to price growth within a 5km radius of the site which can not be explained by wider county-level trends in house prices.

Therefore, in Part 2 Cebr attempt to answer the following question: **What effect does the presence of a wind farm have on house price growth within 5km which can not be explained by the business cycle or trends at the county level? Can we say that, with a certain level of confidence, based on the sample of transactions and sites studied, that there is a statistically positive or negative effect on house price growth arising from the presence of the wind farm?**

# Executive summary: Key findings

## Part 1: Presentation of raw house price data

Our analysis of the raw house price data for transactions completed within the vicinity of the wind farms yielded **no evidence that prices had been affected by either the announcement, construction or completion of the wind farms for six out of seven sites.**

In fact, the analysis shows that on average, house prices near wind farm sites grew faster for the periods between the start of construction and mid-2013 (0.8% annual growth) than at the wider county-level (0.5% annual growth). One site did see a noticeable downturn following the announcement that a wind farm would be built; however once the turbines were erected, local house price growth returned to the county-wide norm.

## Part 2: Econometric tests

The second part of this study focussed on establishing whether the announcement, construction or completion of the wind farm causes a statistically significant impact to price growth observed within a 5km radius of the wind farm. In other words, we remove the effect of price variations caused by the natural business cycle and county level trends, and then ask whether the residual differences coincide with the presence of the wind farm. To place this into context, we are testing whether there is a significant difference between the way house prices behave within 5km of the wind farm (an area covering approximately 79 sq km) and the wider county area (on average, covering 2,200 sq km) as a result of the wind farm installation.

# Executive summary: Conclusion

## Part 2: Econometric tests cont.

Three tests to establish whether the wind farm installation had any significant effect across the five sites were undertaken:

- **Test 1:** Over the period between announcement of plans to construct wind farm and present day – no statistically significant difference and no negative impact on house price growth within 5km of a wind farm;
- **Test 2:** Over the period between start of construction and present day – statistically significant positive impact on house price growth found within 5km of a wind farm;
- **Test 3:** Over the period between wind farm completion and present day – statistically significant positive impact on house price growth found within 5km of a wind farm.

**For all three econometric tests conducted, we found no negative impact within 5km of a wind farm installation.**

## Conclusion

Although the number of case studies is limited, this report and its findings provide project-specific evidence on the impacts of wind farms on house prices. **Together the descriptive and econometric analyses show that across the sites analysed, there is no evidence to suggest that there was a long-term negative impact on house prices, either during the period of construction or post completion of the wind farms.**

# Context



# Context

Much media coverage of wind farms presumes that they have a negative impact on local house prices, but there is no clear evidence to show whether or not this is the case.

Expert academic research published in the UK and abroad shows there is no conclusive evidence that wind farms consistently, measurably or significantly affect house prices (see details on the following slide).

Any change in local community infrastructure may be unwelcome to some people, with the anticipation of an impact on the current and future value of properties often leading to opposition from a vocal minority within these communities.

To see whether there is any discernible effect of wind farms on nearby house prices and shed further light on the subject, the industry decided to examine a representative sample from across England and Wales.

# Existing research & commentary

Existing research and commentary present a mixed picture. There have been many studies but no conclusive evidence:

*“There is no definitive answer to this question.”* [The Royal Institute of Chartered Surveyors \(March 2012\)](#)

*“The view of estate agents was that proximity to a wind farm simply was not an issue”.* [‘What is the impact of wind farms on house prices?’](#), Oxford Brookes University for RICS (2007)

*“Studies are not at all agreed...[some say] house prices have actually increased after erection of a wind farm.”* [Parliamentary Briefing Note \(July 2012\)](#)

A study in the Scottish Borders found house prices actually rose over a four year period when the wind farm was built and began generating energy. [‘The Impact of Wind Farms on Residential Property Prices - Crystal Rig Case Study’](#), (February 2007)

A statistical analysis of house sales in areas where wind farms are located found no evidence of impact. [‘A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States’](#), (Aug. 2013)



# Research parameters

# Research overview

In order to understand the effect of wind farms on house prices in the surrounding local area we must account for the fundamental factors which drive house prices. This enables us to isolate any impact caused by the wind farm in particular.

The best way to analyse the data and give some degree of certainty on the effects of wind farms on local house prices is to use a statistical tool known as 'time-series regression analysis'. This allows us to account for the factors that influence local house prices and isolate the effects of wind farms.

With this in mind, the study is structured into two parts:

- In part 1, we discuss and analyse house price growth near wind farm sites and at the wider county level.
- In part 2, we undertake econometric tests which examine whether the wind farm installation results in a significant divergence in house price growth between the area near the wind farm site and the wider county level.

# Geographical scope of the study

The purpose of this study is to identify whether there are medium to long-term impacts of wind farms on house prices in the surrounding area, which will allow us to better understand if they are having a different impact from other infrastructure developments.

To ensure the study is representative of England and Wales, where possible we identified one wind farm in each English region and in Wales. The size of the wind farms ranged from two to twenty-six turbines to give a broad mix and to reflect the scale of wind energy developments in each region. We also used a mix of wind farm developers. Sites were chosen where construction was completed to enable evaluation of the medium and long-term impacts.

There are no wind farms currently operational in the West Midlands and it was not possible to secure participation of a wind farm in the East of England. The study therefore covers six regions and Wales, giving a total of seven wind farms.

For the econometric study, the Kiln Pit Hill Site in Durham (NE) and Little Cheyne Court in Kent (SE) were excluded after it was found that sampling bias\* existed in the data due to the small number of property transactions (which is to be expected given developers do not site wind farms close to residential areas). The number of detached property transactions (which tend to be of higher value and low volume) were particularly volatile. This skewed the consistency of the price series. For more detail on this point please see the appendix, which details the modeling used in the econometric study.

\* Sampling bias in the context of this study describes an error in a data sample caused by the unequal collection of data from different housing types within the population. In this case, the low number of property transactions has created a persistent error in the sample. This results in perceived changes in the average property price being driven by the errors, not market performance.

# Wind farm sites

County	Region	Wind farm name	Size	Date of construction commencement
Kent	South East	Little Cheyne Court	26 turbines	Sept. 2007
Cornwall	South West	Roskrow Barton	2 turbines	Sept. 2007
County Durham	North East	Kiln Pit Hill	6 turbines	Nov. 2010
Lancashire	North West	Scout Moor	26 turbines	Apr. 2007
Sheffield	Yorkshire & the Humber	Loscar	3 turbines	Apr. 2010
Nottinghamshire	East Midlands	Lindhurst	5 turbines	Jan. 2010
Neath Port Talbot	Wales	Ffynnon Oer	16 turbines	May 2005

\*Sites were chosen where construction was completed to enable evaluation of the medium and long term impacts.

There are no wind farms currently operational in the West Midlands.

We were unable to secure the involvement in the study of a wind farm in the East of England.

# House price data

We sourced data from Calnea Analytics, a leading provider of residential property market data, analysis and automated valuation services. Calnea Analytics provided average house prices and transaction volumes from the Land Registry.

These were sourced for the following:

- House prices within:
  - 1km of each wind farm;
  - 2km of each wind farm;
  - 5km of each wind farm;
- County each wind farm is located in.

Data was sourced for the period from 1 January 1995 to mid-2013. This enabled a comparison and analysis across the time period of each wind farm – from before the plans were known, to the period between plans being made public and construction taking place, and after completion.

The average housing type mix across the time period was applied to the data to ensure comparability between the periods.

# Study area criteria

The wind farm sites are located in relatively sparsely populated areas with low average transaction volumes. The 1km and 2km radius areas do not have the same density of transactions as the wider 5km radius area for each of the sites, given developers tend to site wind farms away from built-up areas.

For the period 1995 to mid-2013, only 415 properties were sold across the seven sites at the 1km radius level and 4,343 properties at the 2km level compared to 82,223 transactions at the 5km level.

**The low volume of transactions therefore restricted the study to utilise solely house price data for the 5km radius area.**

# **PART 1: Presentation of raw house price data for sites near seven wind farms across England and Wales**

# Part 1: Key findings of price analysis

When comparing house prices near the seven wind farms to their respective county averages there was no evidence to suggest that house prices near wind farms had been affected.

Average annual house price growth within 5km radius of the wind farm and at county level – across the seven sites:

	Period before plans made public	Period from plans made public to construction commencing	Construction period	Period after construction	Annual average increase from year before construction to mid-2013
<b>5km radius – Annual growth (%)</b>	7.1%	11.4%	8.7%	-1.4%	0.8%
<b>County – Annual growth (%)</b>	6.9%	11.2%	3.8%	-0.7%	0.5%

- The analysis shows that on average across the seven sites, house prices within a 5km radius from wind farms grew faster following construction (0.8% annual growth) compared to their respective counties (0.5% annual growth).
- For six sites, property values at the local level did not deviate sufficiently from the county average to suggest that the planning and construction of wind farms had an effect on house prices.
- For one case – Kiln Pit Hill (NE) – a substantial downturn in property prices at a 5km radius from the wind farm was observed relative to the county average, prior to construction. However, once the turbines were erected local house prices recovered, remaining above the county average. Moreover, given the very low number of transactions within a 5km radius of the site, the data for this site was deemed insufficient for the econometric analysis and was excluded.



# Part 1: Scope

This section presents trends in house prices at the local and county level before and after wind farm construction. The approach for the analysis is to examine the performance of local house prices at individual sites in more detail and see whether there was a noticeable deviation from the county average before, during and after the erection of turbines.

The analysis allows us to examine whether the performance of local house prices has deviated from the county norm. A deviation from this relationship following construction suggests that the wind farm – or some other factor – may have affected local house prices.

The analysis looks at each of the seven wind farms in turn, providing:

- A description of the wind farm's location and key dates;
- A graph tracking the change in house prices at a 5km radius from the wind farm site against the county mean;
- A review of the findings seen in the graph.

Any findings from this analysis are indicative, given that we did not control for other factors that may affect house prices, such as local housing supply and availability of local employment. The purpose of the analysis is therefore to give a sense for how house prices near wind farms have evolved before and after construction.

# Little Cheyne Court

South East England

# Little Cheyne Court Wind Farm



Little Cheyne Court Wind farm – built by RWE npower renewables – is located 7km west of Lydd on Romney Marsh, in the county of Kent. The 26 wind turbines, each 115m high, are distributed over an area of 4km<sup>2</sup>, with installed capacity of up to 59.8 MW.

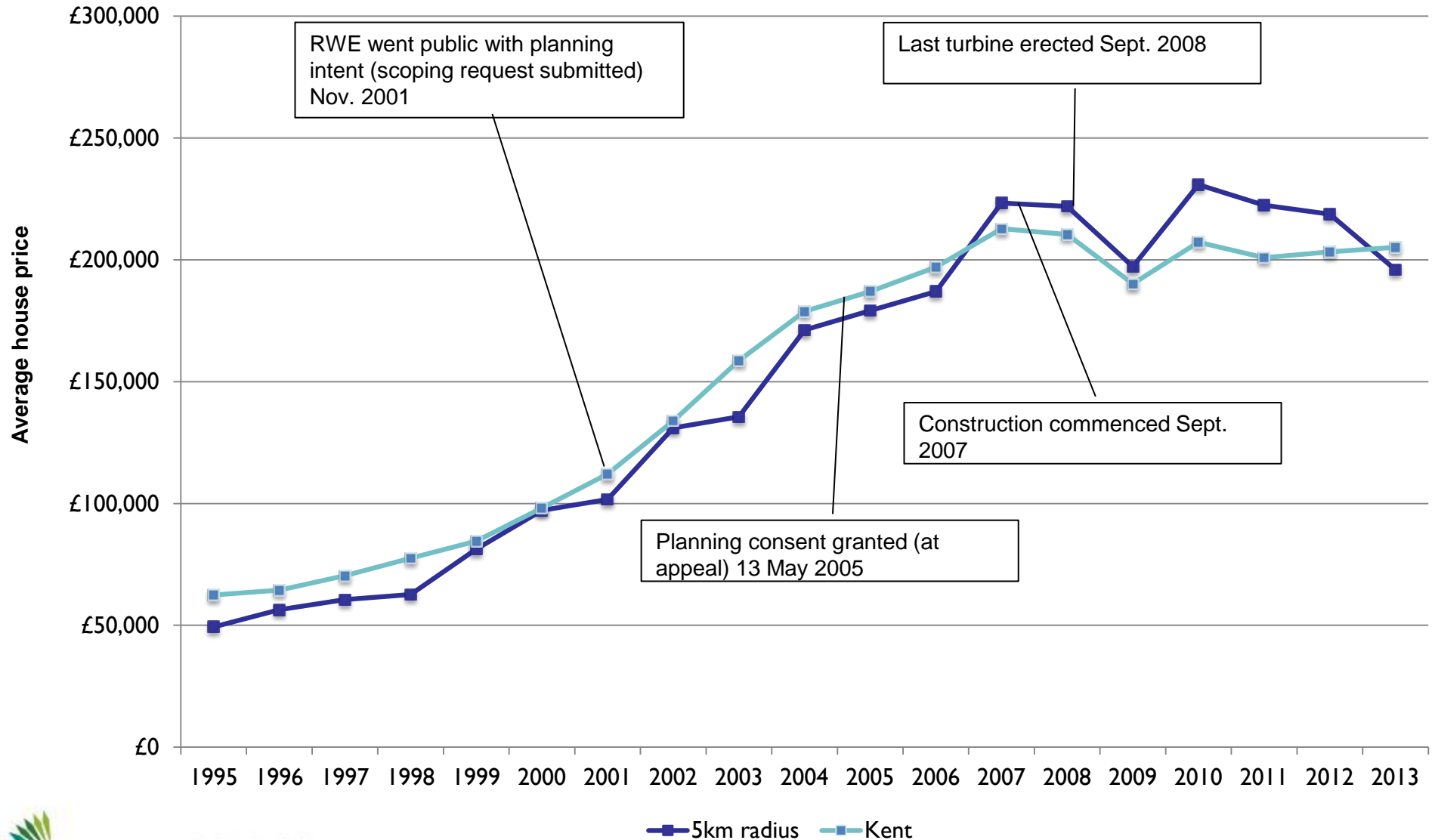
A fact sheet for full details about Little Cheyne Court (LCC) Windfarm can be found [here](#).

For the purpose of this study, the key dates to be aware of are as follows:

- RWE npower renewables went public with plans for LCC wind farm (scoping request submitted)\*: November 2001
- Planning consent granted (at appeal): 13 May 2005
- Construction commenced: September 2007
- Last turbine erected: September 2008

\*Please note that this date is estimated from scoping and planning application timescales as available.

# Local and county house prices



# Little Cheyne Court Analysis

The graph on slide 20 shows that in the year prior to construction commencing at Little Cheyne Court wind farm in 2007, average property prices within the 5km radius grew faster than the county level, allowing average prices to overtake the average in Kent in 2007.

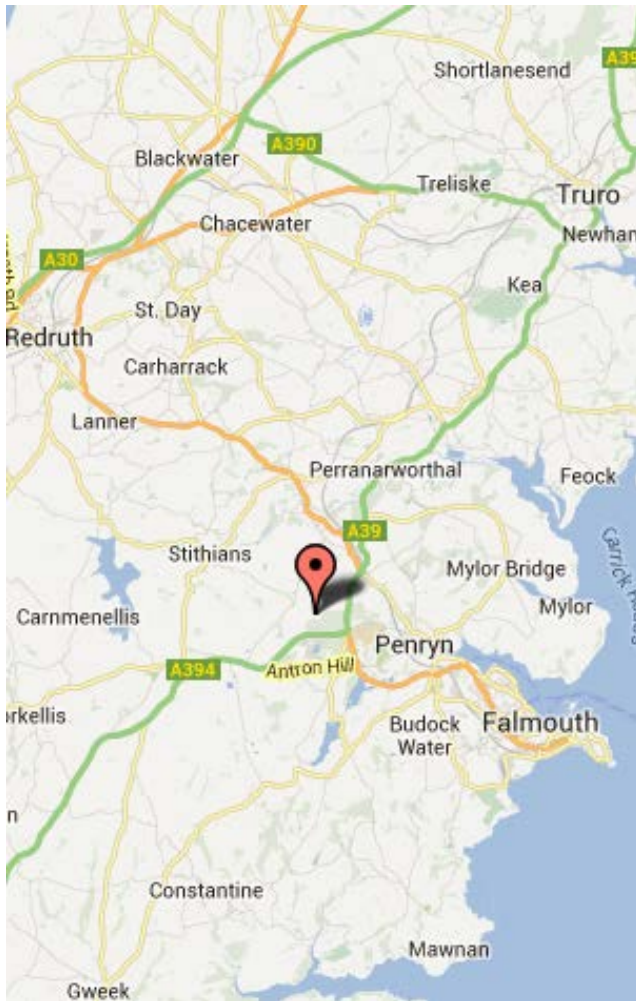
In the period after construction (2009 – 2013), overall prices at the 5km radius level fell by 1% – while average prices in Kent rose by 8%. However, **for the overall period between pre-construction and present day (2006 to 2013) average prices within the 5km radius exceeded the performance at the county level.** House prices within a 5km radius rose by 2% per annum whilst house prices at the county level rose by 1%.

The post-construction time period (2009 – 2013) coincided with a major downturn and recovery of house prices at the national level. London was the first market to recover and performed strongly during the period 2010 to 2013. The influence of London has historically helped support Kent's property values – which means that the Kent average is likely to perform better than peripheral areas such as Romney Marsh where the site is located.

# Roskrow Barton

South West England

# Roskrow Barton Wind Farm

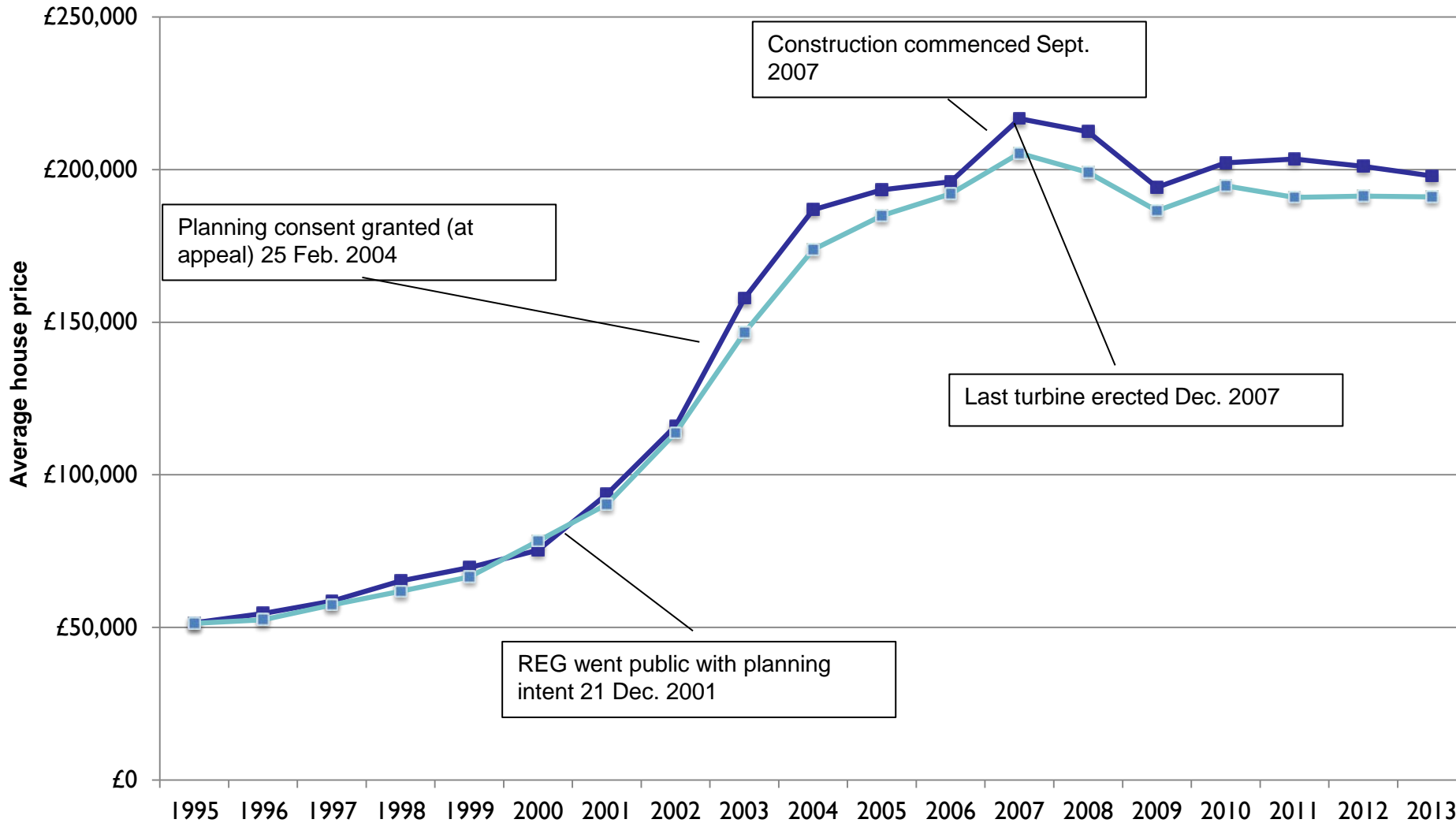


Roskrow Barton wind farm – built by REG Windpower – is located north-west of Penryn, Cornwall. The two wind turbines have a peak generation of 1.7MW.

For the purpose of this study, the key dates to be aware of are as follows:

- REG Windpower went public with plans for Roskrow Barton wind farm: 21 December 2001
- Planning consent granted (at appeal): 25 February 2004
- Construction commenced: September 2007
- Last turbine erected: December 2007

# Local and county house prices





# Roskrow Barton Analysis

Property prices within a 5km radius of Roskrow Barton wind farm grew consistently faster than the Cornwall average between 2001 and 2007 – after REG Windpower went public with planning intent for the wind farm.

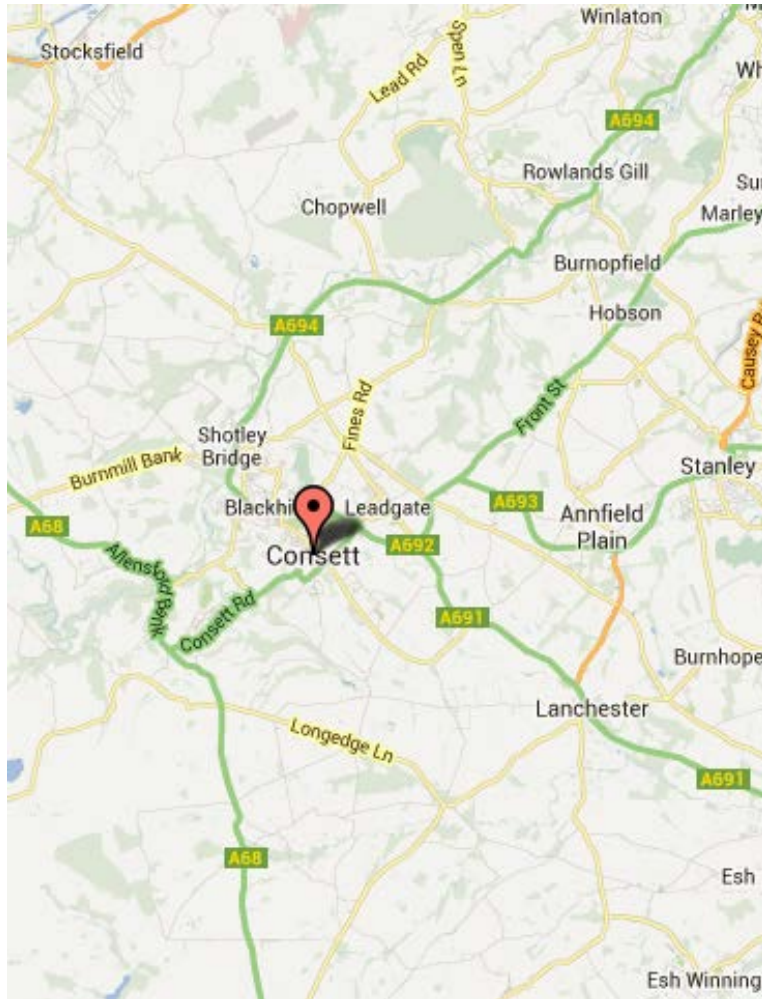
The data shows that following construction of the wind farm in 2007, there was a substantial dip in average property price growth near the wind farm but this was also mirrored by a fall at the county level of similar magnitude. This was most likely reflecting the general downturn in the Cornwall property market.

**The data from Roskrow Barton wind farm indicates there was no unusual deviation of local property prices relative to the county level before, during or after construction.**

# Kiln Pit Hill

North East England

# Kiln Pit Hill Wind Farm

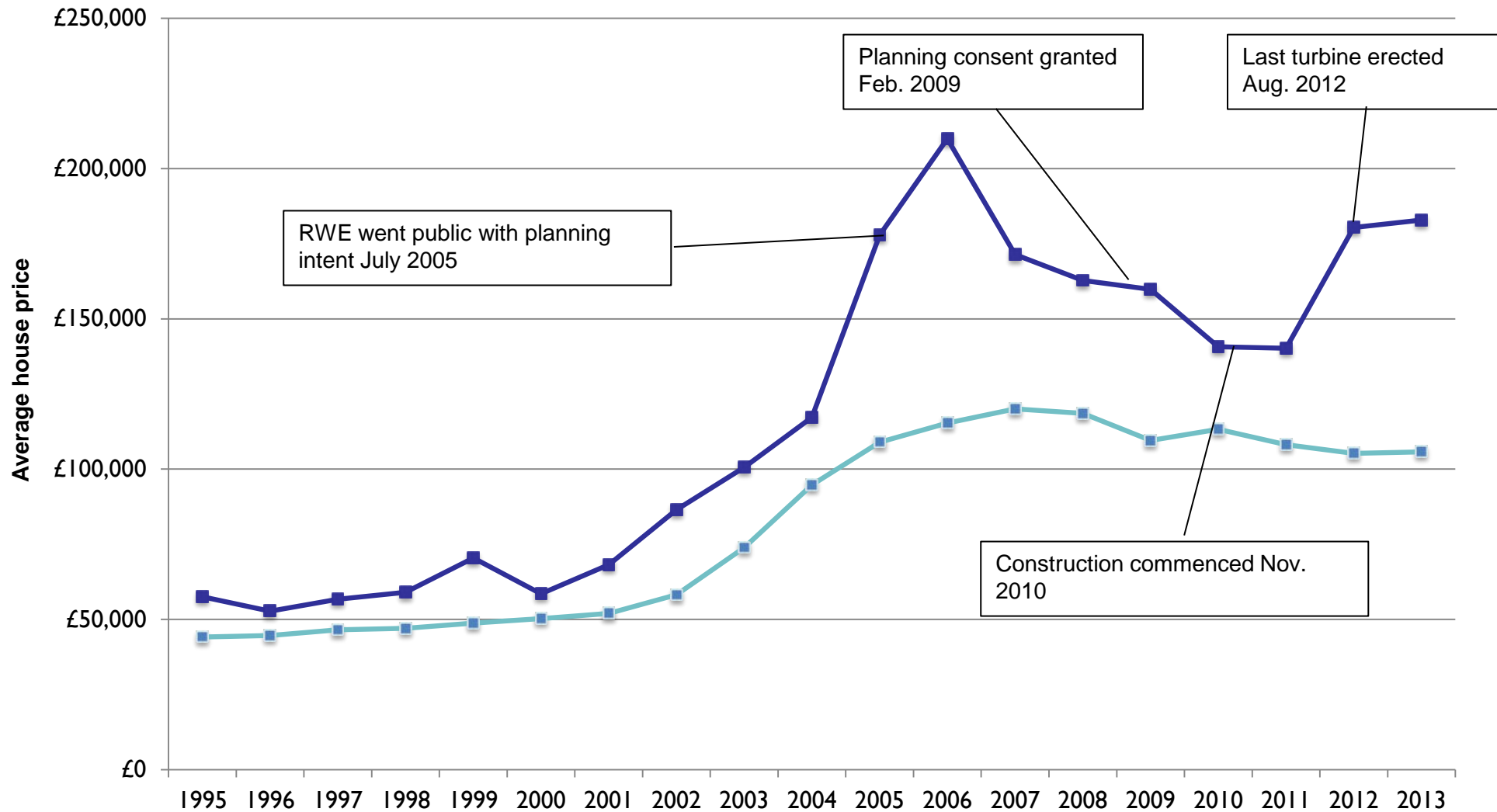


Kiln Pit Hill wind farm – built by RWE npower renewables – is located south-east of Kiln Pit Hill in Northumberland. The six turbines have installed capacity of up to 13.8 MW.

For the purposes of this study, the key dates to be aware of are as follows:

- RWE npower renewables went public with plans for Kiln Pit Hill wind farm (scoping submitted)\*: July 2005
- Planning consent granted: February 2009
- Construction commenced: November 2010
- Last turbine erected: August 2012

# Local and county house prices



# Analysis

Property prices near Kiln Pitt Hill remained higher than the county average before, during and after construction, reaching an all time high in 2006, a year after the plans to build the project were made public and closely corresponding to a peak in UK property prices. However, between 2005 (when the development plans went public) and 2009 (when planning consent was granted) property prices fell by 10% while average values in Durham rose by 4%. This suggests that the anticipation of construction of wind farms could have influenced house prices temporarily in the 5km radius around Kiln Pit Hill wind farm.

However, following construction of the wind farm, prices recovered strongly with average growth of 5% during construction and 1% thereafter, compared to 1% drop at the county level. Overall growth for the period between pre-construction and present day (2009 to 2013) show that property values at the local level have outperformed those at the county level significantly (14%).

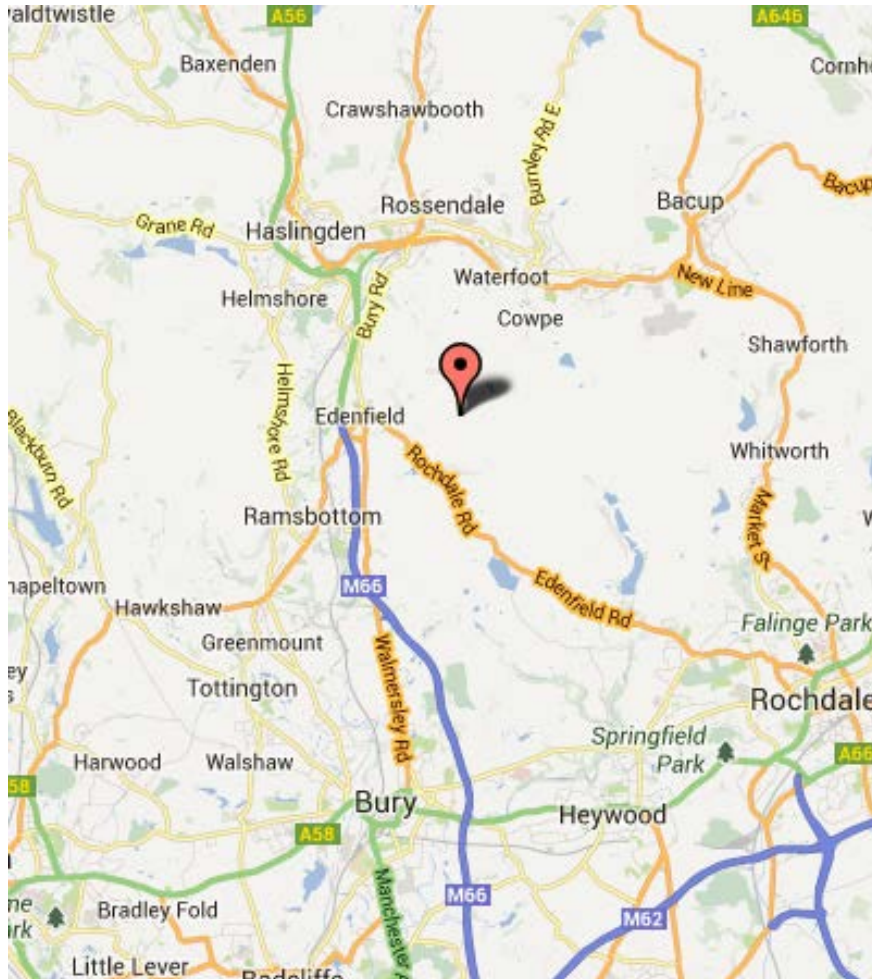
There were a very low number of transactions for this site, which is why it was excluded from the econometric analysis used in the first part of the study.

**We can conclude that although house prices rose after plans to build the project were announced, there is evidence to suggest that prices were temporarily influenced in advance of construction commencing at the site. However, house prices recovered strongly during and after construction, outperforming the county level, suggesting that if the wind farm did have any influence on local house prices, any effect was short-lived.**

# Scout Moor

North West England

# Scout Moor Wind Farm



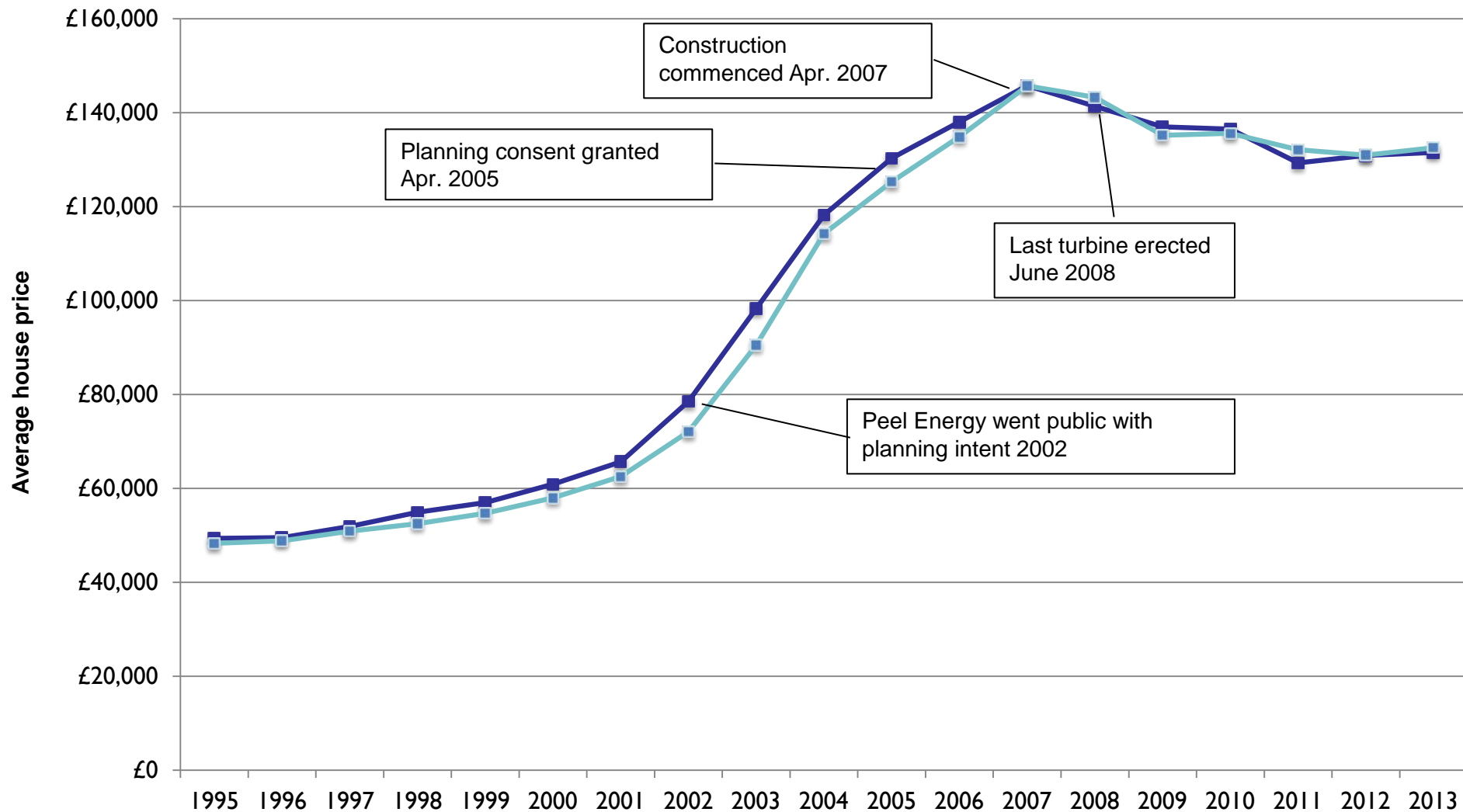
Scout Moor wind farm – built by Peel Energy – is located on moorland in the South Pennines. The 26 wind turbines are distributed over 5.45km<sup>2</sup>, with peak generation of 65MW.

A fact sheet for full details about Scout Moor wind farm can be found [here](#).

For the purpose of this study, the key dates to be aware of are as follows:

- Peel Energy went public with plans for Scout Moor wind farm: 2002
- Planning consent granted: April 2005
- Construction commenced: April 2007
- Last turbine erected: June 2008

# Local and county house prices





# Analysis

Property prices within a 5km radius of Scout Moor wind farm closely track the Lancashire county average. Following the completion of construction in 2009, prices declined at both the county and local level and have failed to return to their pre-recession highs. The consistent decline across the county suggests that the presence of the wind farm did not have an effect on local house prices.

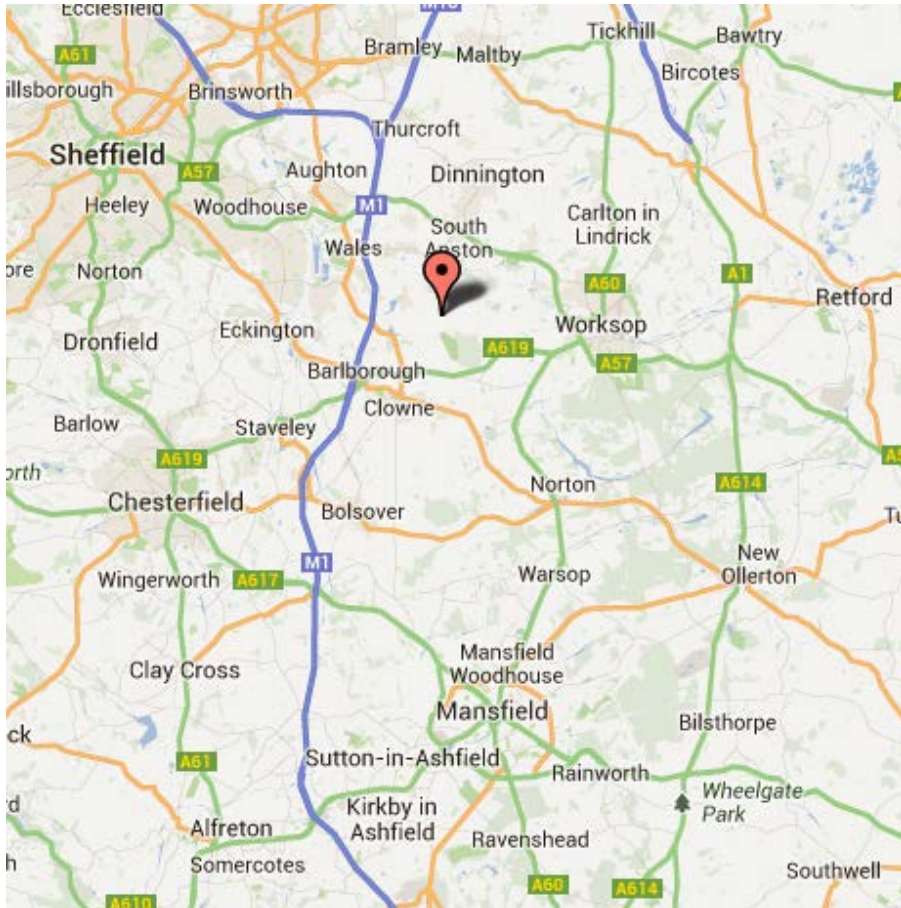
The data for Scout Moor wind farm reveals that local house prices closely tracked the trend in the Lancashire property market before, during and after construction.

**The fact that the close relationship between local and county prices remained intact following construction at the site indicates that the wind farm has not had a discernable effect on house prices within the 5km radius area.**

# Loscar

Yorkshire and the Humber

# Loscar Wind Farm

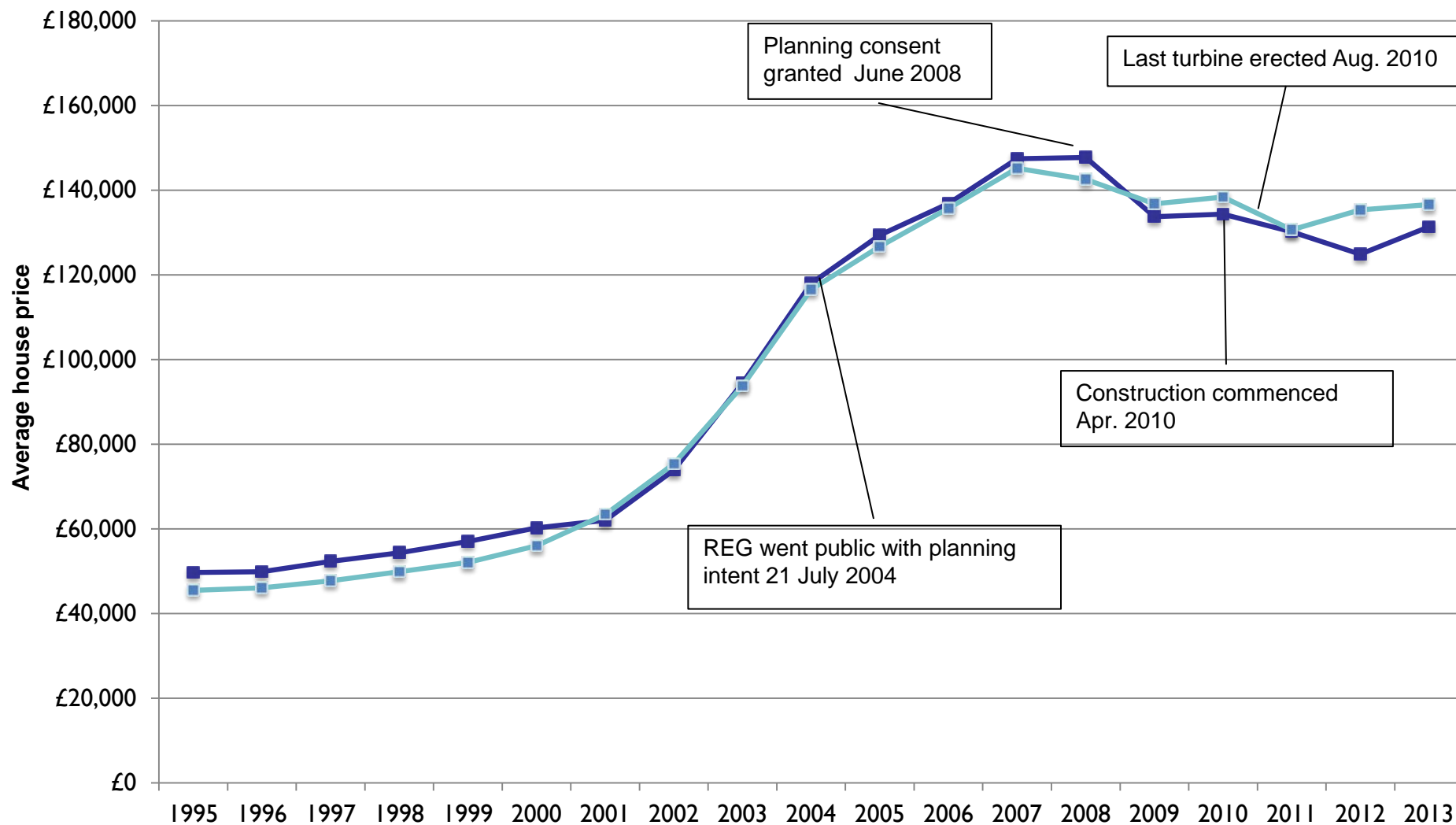


Loscar wind farm – built by REG Windpower– is located north-west of Whitwell, near Sheffield. The three wind turbines have a peak generation of 6MW.

For the purpose of this study, the key dates to be aware of are as follows:

- REG Windpower went public with plans for Loscar wind farm: 21 July 2004
- Planning consent granted: June 2008
- Construction commenced: April 2010
- Last turbine erected: August 2010

# Local and county house prices



# Analysis

The data for Loscar wind farm shows that property prices at a 5km radius of the site broadly tracked the Sheffield county average before, during and after construction at the site.

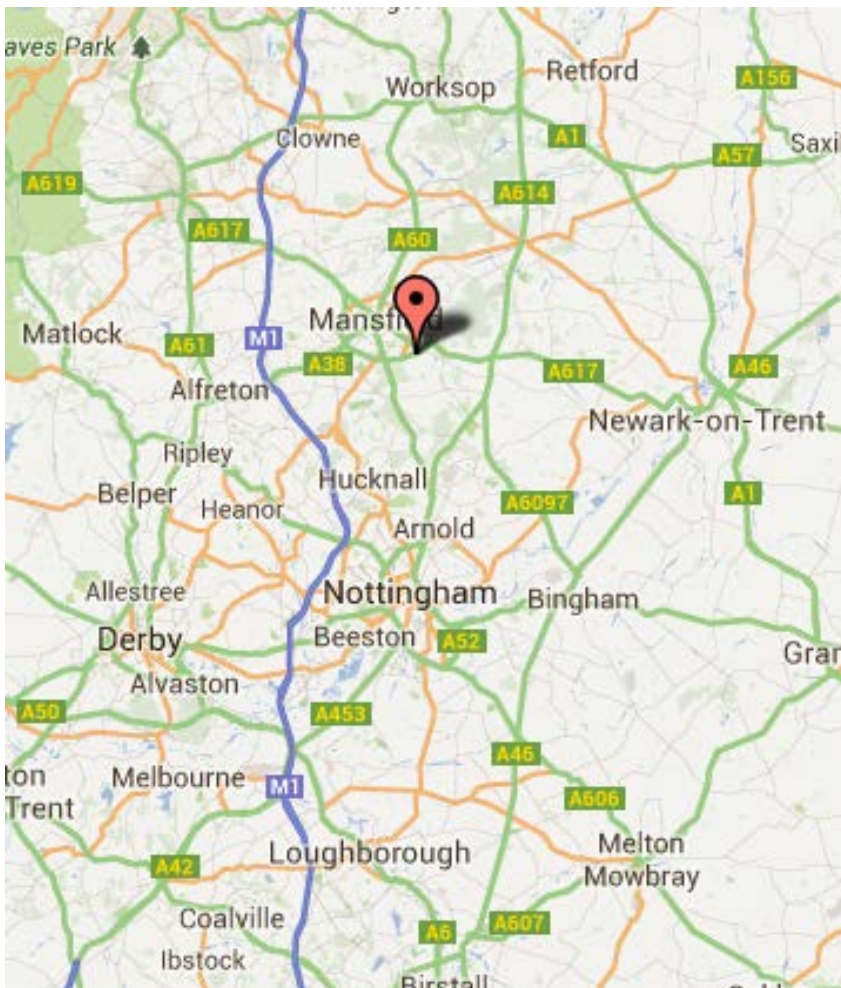
In the year following construction (2011 to 2012), there was a slight temporary dip in property prices at the 5km radius but this was within 1% of the county level. However, property prices recovered in 2012-13.

**The difference between the property market at local and county levels has consistently remained negligible both during and after construction, suggesting that the wind farm has not had an effect on house prices within the 5km radius area.**

# Lindhurst

East Midlands

# Lindhurst Wind Farm



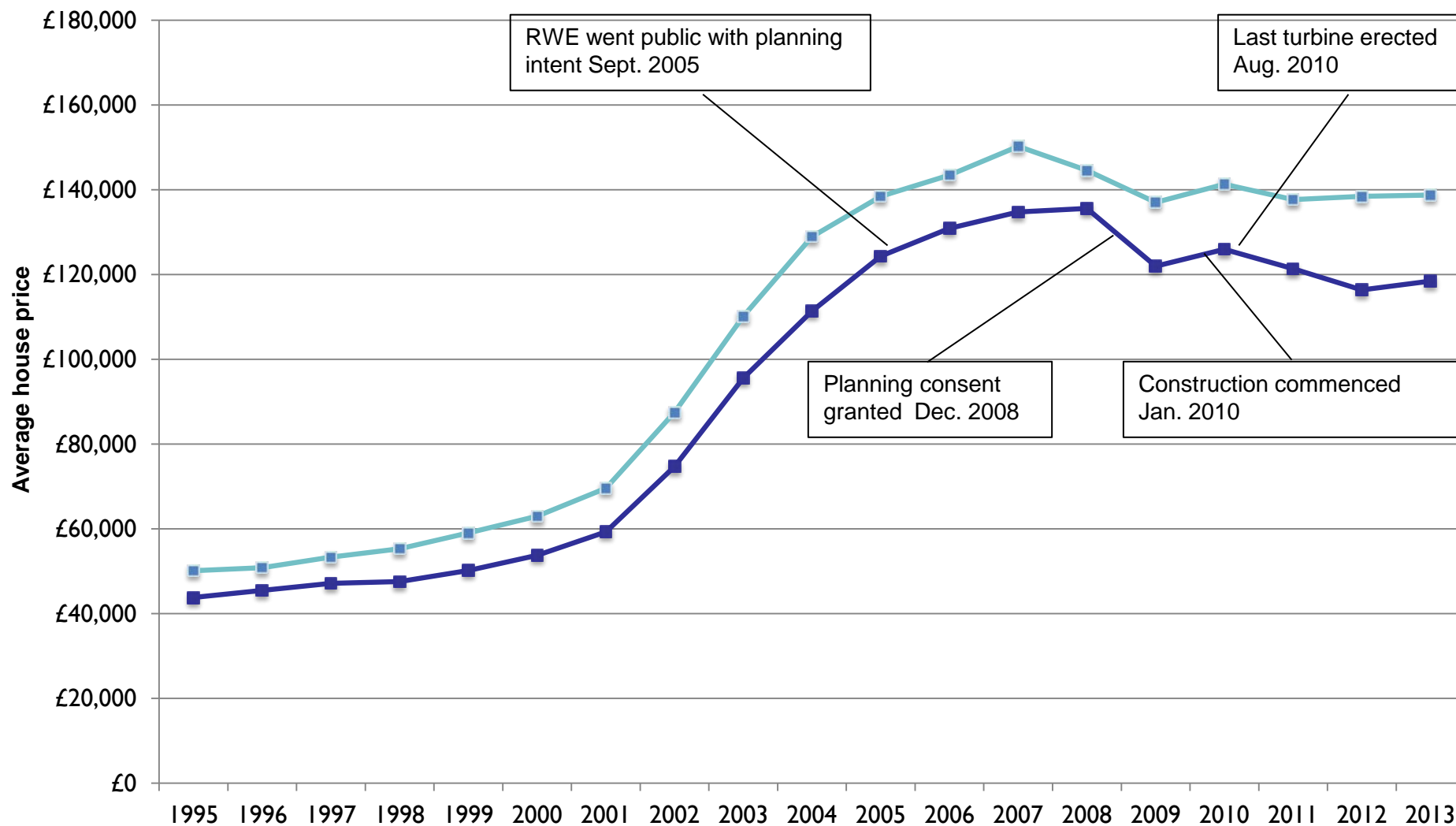
Lindhurst wind farm – built by RWE npower renewables – is located near Nottinghamshire. The five wind turbines have an installed capacity of up to 12.5MW.

For the purpose of this study, the key dates to be aware of are as follows:

- RWE npower renewables went public with plans for Lindhurst wind farm (scoping response received from Council)\*: September 2005
- Planning consent granted: December 2008
- Construction commenced: January 2010
- Last turbine erected: August 2010

\*Please note that this date is estimated from scoping and planning application timescales as available.

# Local and county house prices





# Analysis

The data shows that the performance of property prices within a 5km radius from Lindhurst wind farm has closely tracked the performance of the wider Derbyshire housing market. Prices in the local area were consistently below the county average before plans for the wind farm were even announced.

Continuing this trend, during the period after construction (2011 to 2013), prices in the local area declined on average by 2% per year whilst prices at the county level declined by 1% per year. While this represents a slight deviation, the magnitude is not sufficient to suggest that the wind farm has had an effect on average prices in the area.

**Based on the trends in the data and the prior relationship between local and county prices, evidence does not suggest that the wind farm has had a significant effect on property prices within a 5km radius of Lindhurst wind farm.**

# Ffynnon Oer

Wales

# Ffynnon Oer Wind Farm



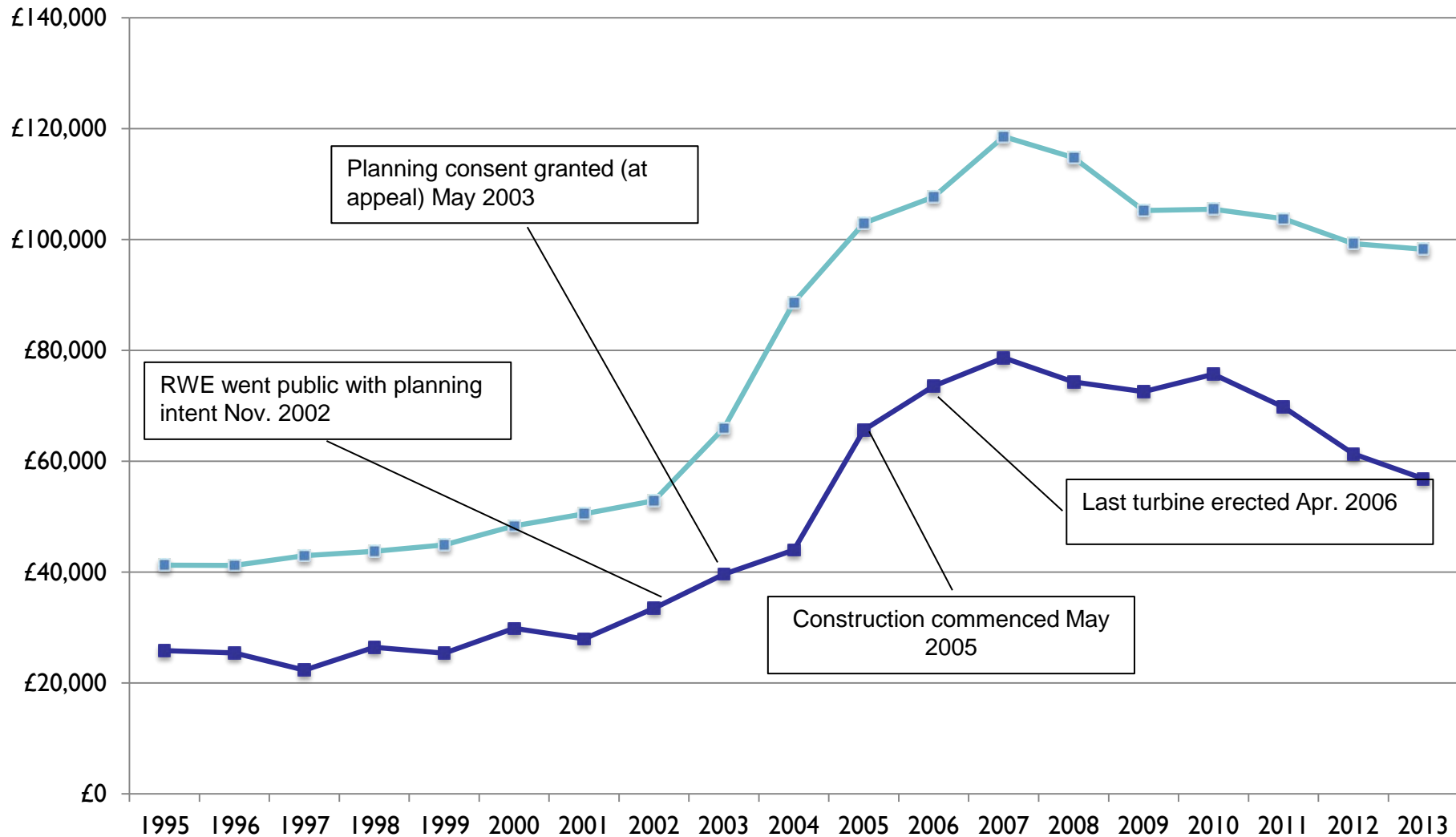
Ffynnon Oer wind farm – build by RWE npower renewables – is located near Glyncorrwg in Neath Port Talbot. The sixteen wind turbines have installed capacity of up to 32MW.

For the purpose of this study, the key dates to be aware of are as follows:

- RWE npower renewables went public with plans for Ffynnon Oer wind farm (scoping application submitted)\*: November 2002
- Planning consent granted (at appeal): May 2003
- Construction commenced: May 2005
- Last turbine erected: April 2006

\*Please note that this date is estimated from scoping and planning application timescales as available.

# Local and county house prices



# Ffynnon Oer Analysis

Ffynnon Oer wind farm has the lowest average house prices amongst the seven sites we examined. This is consistent with the average house price values in Wales which are on substantially lower than the national average.

Property values at both the local and county level grew rapidly before and during construction of the wind farm. House prices at the local and county levels continued to grow during and after construction. Average property values have declined since 2008 in line with the general downturn in the Welsh property market.

The greater decline in property prices at the local level can largely be attributed to the reversal of the growth seen prior to the peak. This is supported by data for the longer period between pre-construction and the present day (2004 to 2013) which shows local prices significantly outperformed those at the county level.

Overall property prices between 2004 and 2013 grew by 29% at the 5km radius (£43,995 to £56,838), compared to 11% overall price growth (£88,635 to £98,239) at the county level.

**Therefore, we can reasonably conclude from the data that the more recent poor performance of the property values within 5km of the site was driven by a general property downturn rather than the construction of the wind farm. Indeed, over the period from pre-construction to mid 2013 there was a significant growth in prices at the wind farm which outstripped performance at the county level.**

# PART 2: Econometric tests for the impacts of wind farm construction on property prices

# Part 2: Key findings of econometric tests

The econometric tests conducted over five sites in England and Wales showed no negative price impacts attributed to the installation of wind farms over the period from either announcement, building or completion to the present day. Three econometric tests were conducted to show whether, after other economic factors such as the natural growth and contraction of the economic cycle (“boom and bust”) were stripped out, there was any significant impact caused by the wind farm installation which was over and above that which could be explained by county-level trends in house prices:

- **Test 1:** Over the period between announcement and present day – no statistically significant difference and no negative impact on house price growth found within 5km of a wind farm;
- **Test 2:** Over the period between start of construction and present day – statistically positive impact on house price growth found within 5km of a wind farm found;
- **Test 3:** Over the period between wind farm completion and present day – statistically positive impact on house price growth found within 5km of a wind farm.

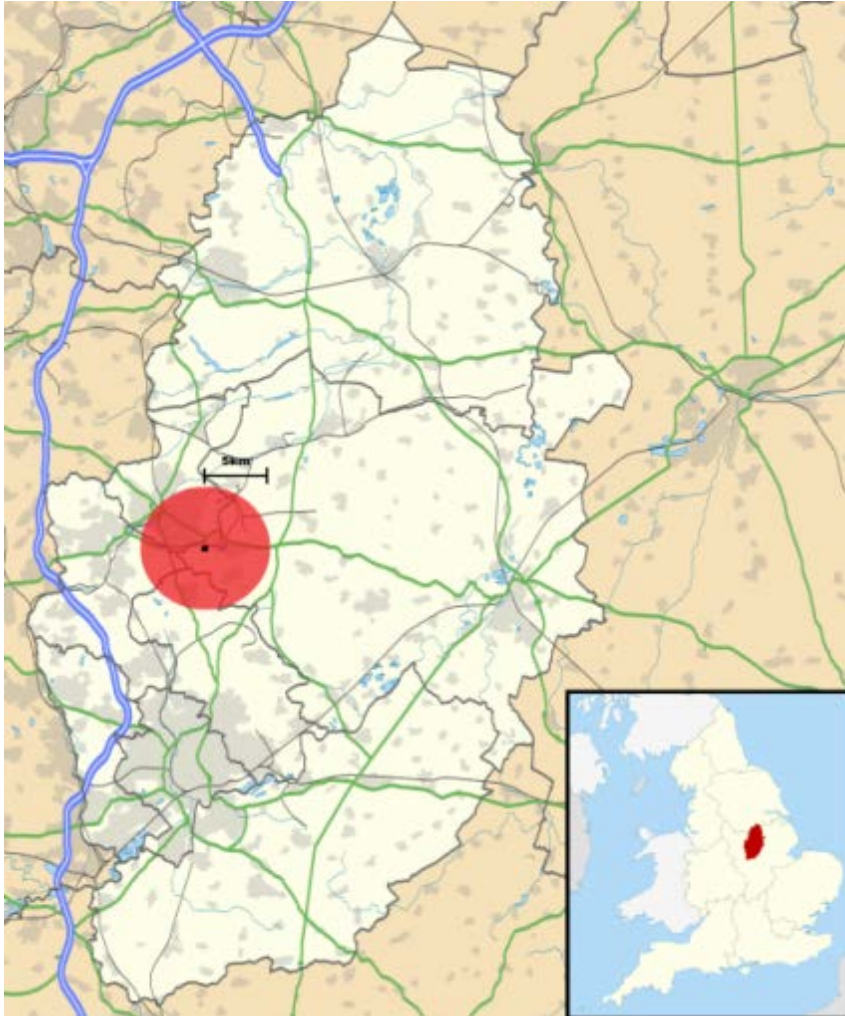
Test 1 showed no significant difference in the price trends observed within a 5km radius of the wind farm when compared to the county level. This means that the wind farm installation had no effect on price growth over the period between plans being made public and the present day.

Tests 2 and 3 found that there was in fact a statistically significant positive impact found within 5km of a wind farm. House prices saw 2% higher annual price growth during the period after construction to the present day, and 1.2% higher growth during the period after completion of the wind farm.

**We conclude that, in all three tests, no negative impact caused by the wind farm installation was found to exist.**

# Basic approach to econometric tests

## Lindhurst, Nottinghamshire



The general approach to the econometric tests is to establish whether the wind farm installation has an effect of local house prices within the 5km radius, which can not be explained by wider county-level trends.

To put this into context, we are testing whether there is a significant difference between the way house prices behave within 5km of the wind farm (an area covering approximately 79 sq km) and the wider county area (on average, covering 2,200 sq km) as a result of the wind farm installation.

The figure to the left provides an example of the areas over which we are conducting the analysis.

### Key:

- Red circle – areas within 5km radius of wind farm
- White area – county-level



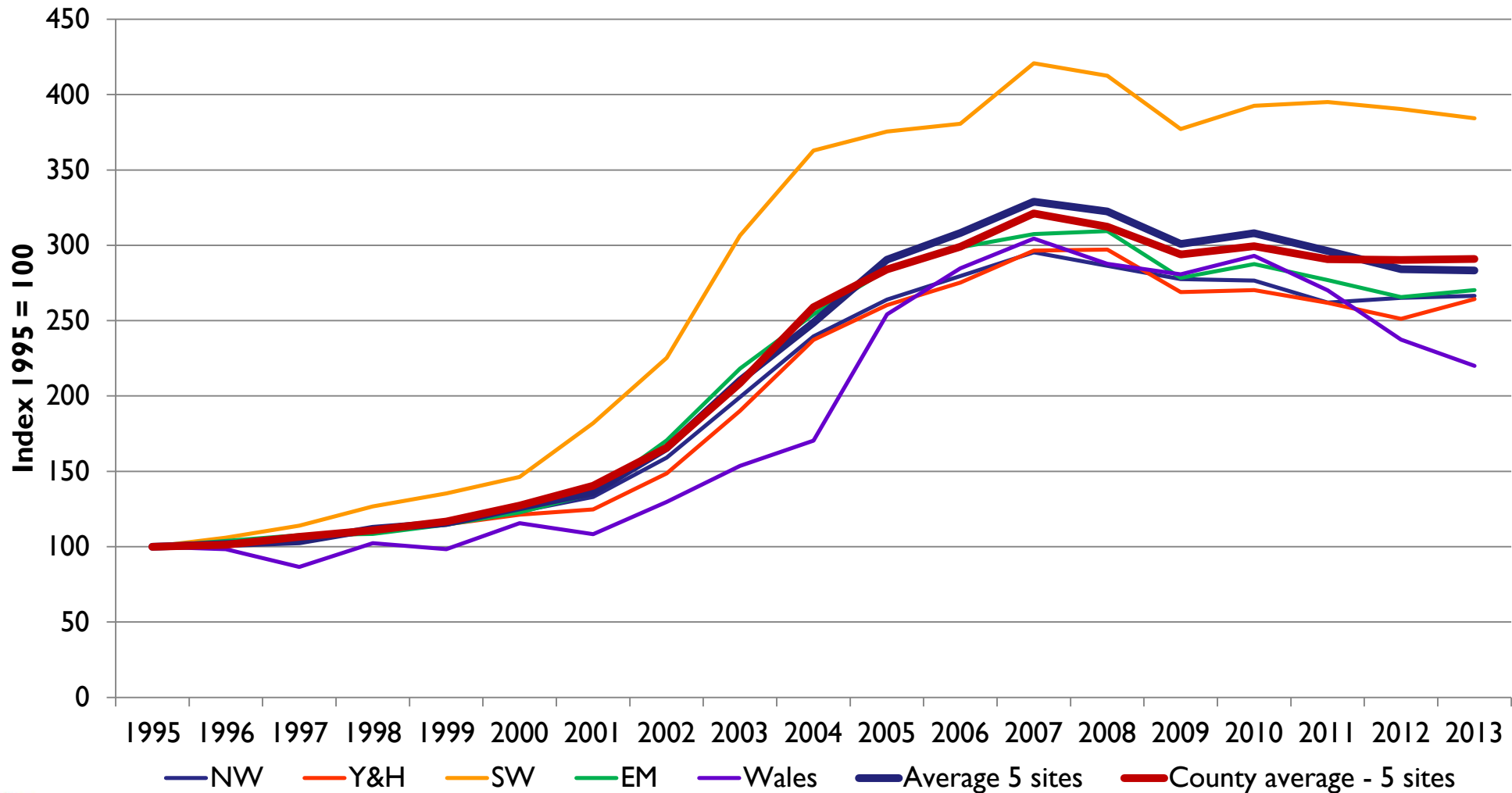
# Initial data analysis – transactions

- For any statistical analysis to produce reliable results, data used must be based on a sufficient number of transactions in the 5km radius.
- The number of transactions in the vicinity of the Kiln Pit Hill site was found to be too low to produce statistically valid results, and this site was therefore excluded from the analysis.
- The Little Cheyne Court (LCC) and Ffynnon Oer sites both show relatively low transaction volumes. This was not a problem at Ffynnon Oer because the sample had a broader distribution of transactions across property types.
- For LCC, however, the data series was skewed due to the impact of the volatility of detached house transactions for specific years. Due to the overall low volumes of transactions, price growth in these years was disproportionately influenced by specific detached property transactions which were not consistent with the underlying change in average local house prices or past performance.

Site	Transactions 5km radius 1995 - 2013
Kiln Pit Hill (NE)	470
Little Cheyne Court (SE)	2,384
Ffynnon Oer (Wales)	2,687
Roskrow Barton (SW)	9,261
Loscar (YH)	11,657
Lindhurst (EM)	24,413
Scout Moor (NW)	30,944

# Initial data analysis – price trends

House price growth index, 1995 = 100, five individual sites, five site average and county average for five sites



# Econometric tests

Cebr carried out econometric tests designed to explain variations in house prices in a 5km radius area near wind farms at five locations around the UK. The tests were based on establishing whether, once we account for the business cycle and county-level trends, the residual change in prices coincides by the presence of the wind farm.

They tested for the significance of periods after various milestones in the planning, development and completion of a wind farm which could indicate an impact on property prices. In summary, the analysis tests for a statistically significant impact on house prices within a 5km radius in the period after:

- The public announcement of the wind farm\*;
- The start of construction;
- The completion of the wind farm.

\*Some of the sites used were in planning for some years and it is unclear from the records exactly when a public announcement of the wind farm was made. In these instances an estimate has been made on the basis of available records (e.g. scoping requests, met mast planning submissions, newsletter dates). Where information was not found of these events the date of the planning submission has been taken as the “public announcement of the wind farm”. For this reason dates of public announcement are in some instances approximate (these are clearly identified on the individual site slides).

# Econometric results

## **Test 1 – Testing for impacts after plans made public**

This econometric test established whether there was a significant impact caused to local house prices following the plans for wind farm being made public, which could not be explained by the business cycle or wider county trends in house prices.

The econometric analysis is based on cyclically adjusted data. This is done so we do not confuse any positive or negative price impacts associated with the wind farm with the time at which it was being constructed. Our findings show that most wind farms were constructed when there was declines in house prices brought on by the 2008 recession and we must therefore strip out this effect.

The findings of Test 1 were that prices within the 5km radius broadly responded to changes in county house prices and the effect of announcement of the wind farm was found to be statistically insignificant.

## **Test 2 – Testing for impacts after construction started**

See chart on following slide.

## **Test 3 – Testing for impacts after completion**

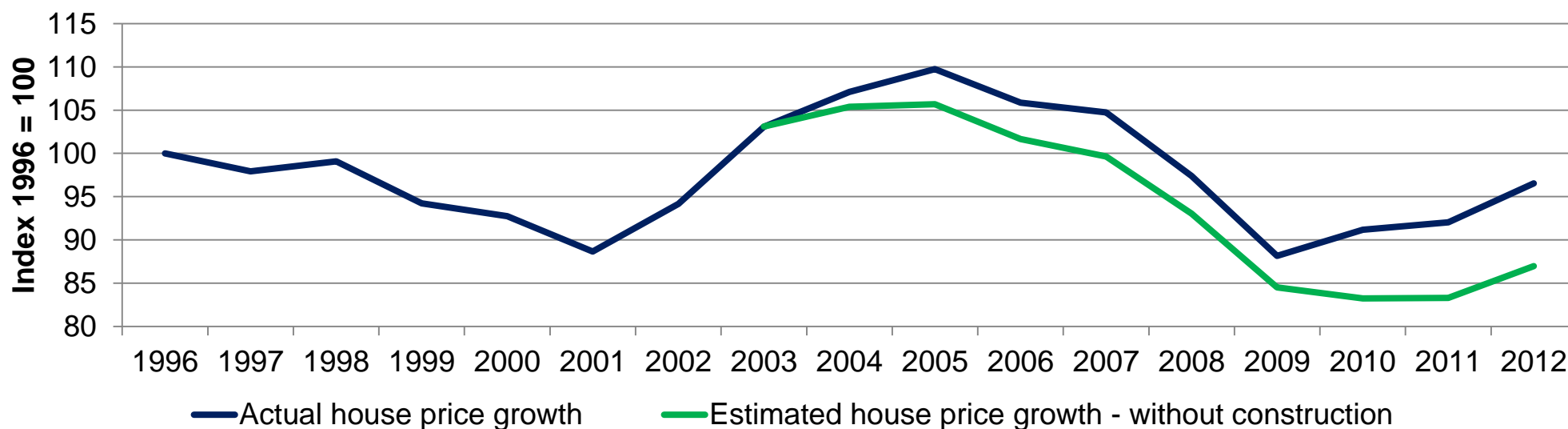
This test yielded similar findings suggesting that there was a positive effect on house prices within 5km of a wind farm in the period following completion.

# Econometric results

## Test 2 – Testing for impacts following the start of wind farm construction

This econometric test established whether there was a significant impact caused to local house prices following the start of construction, which could not be explained by the business cycle or wider county trends in house prices. The chart below presents cyclically-adjusted house price data. The graph indicates that actual house prices within 5km of these wind farms would have been lower without the construction of the wind farm.

**Cyclically-adjusted house price growth index, 1996 = 100, five individual sites – 5km radius, actual price growth and estimated house price growth without wind farm construction**



# Econometric results – summary & interpretation

	Result
<b>Test 1: Period after plans made public</b>	The results show that no statistically significant effect on local house price growth was detected for the period following plans being made public.
<b>Test 2: Period after construction started</b>	The results show that a statistically significant 2% positive effect on local annual house price growth for the period after construction started. This means that on average, annual local house price growth across the five sites was 2% higher than would have been predicted based on the relationship with county level house prices.
<b>Test 3: Period after completion</b>	The results show that there was a statistically significant 1.2% positive effect on local house price growth for the period after construction was completed. This means that on average, annual local house price growth across the five sites was 1.2% higher than would have been predicted based on the relationship with county level house prices.

**Overall the analysis found that the county-wide property market drives local house prices, not the presence or absence of wind farms.**

# Econometric conclusion

Covering five different wind farm sites across England and Wales, the econometric analysis found that after controlling for other factors, house price growth near these five sites experienced a small positive effect for the period following start of construction and a small positive impact after construction was completed.

We can conclude that local house price growth at these sites is best explained by variations in the county level property market. When homebuyers came to purchasing a property in areas within 5km of wind farm sites, it appears that other factors that determined demand for property, such as the supply of new housing and the condition of the local economy, were more influential than the fact that a wind farm was located nearby. This resulted in properties on average retaining their value.

**The econometric analysis established that construction of wind farms at these five sites across England and Wales has not had a detectable negative impact on house price growth within a 5km radius of the sites.**

# Methodological appendix



# Model description

Cebr tested a range of variables for significance in explaining variations in local house price growth across the wind farm sites including the district unemployment rate, district population growth, volume of local property sales, local employment and changes in local housing stock.

However, we found that most of the variation in local house price growth is best explained by variations in average price growth at the county level. The county property market performance is a key determinant of what happens at the site level. This means local property markets are not detached from the county property market – they are very much integrated into the trends in movements that occur in neighbouring localities.

Intuitively, this makes sense given that demand for properties at the local level may be driven by buyers living outside the area or in other parts of the county. The ability of buyers to purchase these properties is influenced by macroeconomic factors that also influence the county property market such as the availability of employment, availability of credit and level of economic activity. This effects demand for properties at the county level.

The econometric model includes county house price growth, county house price growth in the previous year and the following indicator variables representing either; the year of planning application approval, year of start of construction and year of construction completion.

# Modelling approach

## Approach

- The ideal approach for establishing whether wind farm construction has an effect on local house prices (given the available data) is to carry out a regression analysis that pools data for all seven sites and control for drivers of house prices at the local level. Pooling data yields a much larger number of observations which improves the accuracy of any findings. This approach is called a 'panel regression'. Panel data vary across time as well as the groups that are being observed. In this case, data varies across an 18 year time period (1995 to mid-2013) and the seven wind farm sites.
- House price series presented in this study are built using data from Land Registry. For comparability purposes, it was required that the same mix-adjustment method was used for both the local and county level series.
- It was not possible to test for an effect purely at 1km, or 2km, for example, due to the low numbers of transactions. This is not surprising for wind farm sites in the UK given the tendency to locate sites away from high concentrations of residents. Therefore a larger area of 5km was used, capturing all data points within this radius.
- After further investigation of the data, both the Kiln Pit Hill site in Durham and Little Cheyne Court site in Kent were excluded from the analysis dataset in part 2 (econometric analysis) after it was found that sampling bias\* existed in the data due to the small number of property transactions within 5km radius of these sites.

\* Sampling bias broadly describes an error in a data sample caused by the unequal collection of data from different groups within the population. In this case, the low number of property transactions has created a persistent error in the sample. This results in perceived changes in the average property price being driven by the errors, not market performance.

# Modelling approach

## Estimation

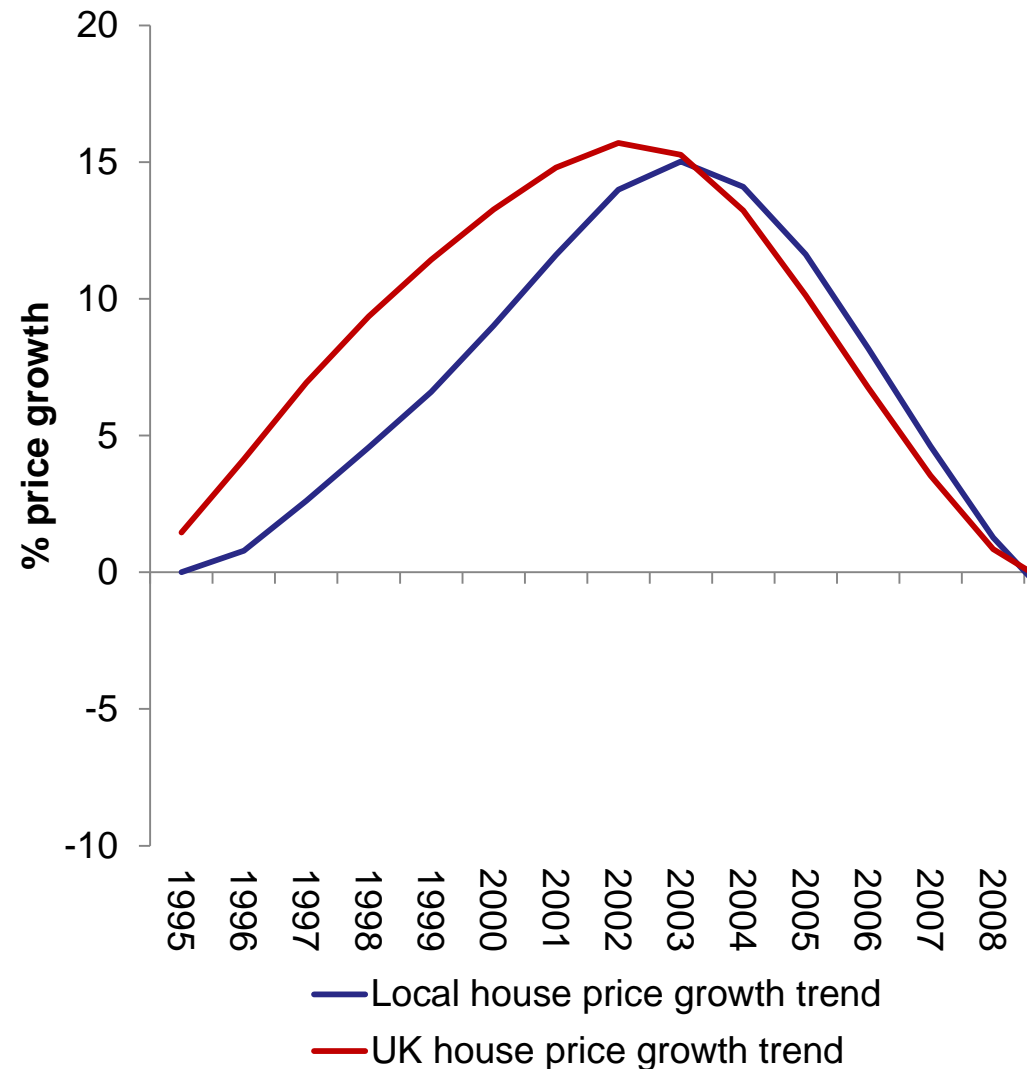
- A key benefit of the panel regression approach is the ability to control for site specific locational factors, whether observable or unobservable, that are constant over time.
- This allows for us to control for effects that cannot be observed directly and don't change over time that are likely to make local house prices higher in some areas relative to others. These could be, for example, site-specific characteristics such as climate, natural beauty and accessibility to employment locations that make an area more desirable.
- We tested for the relative efficiency of a fixed effects approach (whether site specific effects are non-random), and found that maintaining this assumption was not required. This indicates that these site-specific factors are not significant drivers of the level and growth of local house prices near the sites.

## Detecting the effect of wind farm construction and operation

- The methodology allows for the inclusion of an indicator variable that captures the effect on local house prices of changes between the period before and after construction of the wind farms.
- This variable is designed to capture any time-varying change in the period post construction that has not been already controlled for by the explanatory variables.
- If the wind farm has caused house prices to be lower than they should have been after controlling for other factors, it would be expected that the indicator variable would show a negative sign and be statistically significant in driving changes in house price growth.
- A statistically significant positive sign or a non-significant result would suggest either that a negative effect does not exist or is too small to detect given the other factors that may have a higher influence on house prices.

# Accounting for the cyclical trend in house prices

- National, county and local house price growth all follow a similar cyclical trend that peaked in 2003. This trend is caused by property market dynamics, monetary policy and the performance of the economy.
- This trend influences the direction of local and county house prices. This prevents an analysis that compares whether a wind farms affect house prices in different time periods.
- Without accounting for this cyclical trend, any statistical analysis would likely produce flawed results.
- Due to the specification of the model, this cannot be fully controlled for within the regression.
- To address this, we removed the trend from the house price growth series at local and county level.



# Results – econometric overview

<b>Dependent variable: house price growth – 5km radius (cyclically-adjusted)</b>			
<b>Explanatory variables</b>	<b>Plans made public</b>	<b>Construction commencement</b>	<b>Construction completion</b>
Plans made public	0.010		
Construction commencement		0.020**	
Construction completion			0.012***
County house price growth	0.635**	0.722***	0.725***
County house price growth – previous year	0.235	0.232**	0.228**
<b>Constant</b>	-0.006	-0.006*	-0.004***
Number of observations	80	80	80
R <sup>2</sup> within	0.11	0.48	0.47
R <sup>2</sup> between	0.73	0.30	0.19

Legend: p<0.05\* p<0.01 \*\* p<0.001\*\*\*

- The regression described in the table above represents the specification that best explains the evolution of price growth at the site level.
- Five sites were covered by the analysis. The Kiln Pit Hill site (NE) and Little Cheyne Court site (SE) were removed from the analysis after it was found that sampling error existed in the data due to the small number of property transactions which resulted in consistent upward bias in the data points. Such errors were found to be uncorrelated with the underlying data and therefore would result in inconsistent results of data from these sites were included.
- The ‘R<sup>2</sup> within’ and ‘R<sup>2</sup> between’ represent the proportion of variance explained by the explanatory variables at the site level and between the sites respectively.
- A range of different specifications and variables were tested in order to arrive at the most appropriate specification for the model.

# Regression specification

Regression functional form:

$$L_{it} = \alpha_i + \beta_1 C_{it} + \beta_1 C_{it-1} + \beta_1 D_{it} + u_i + \varepsilon_{it}$$

Where:

$L_{it}$  represents growth in the average house price within a 5km radius of the sites (cyclically-adjusted series)

$\alpha_i$  represents a site-specific constant

$D_{it}$  represents a dummy variable in each of the three models signifying period after of plans made public, period after of construction commencement and period after construction completion at each of the sites

$C_{it}$  represents county level house price growth (cyclically-adjusted series)

$C_{it-1}$  represents county level house price growth from the previous year (cyclically-adjusted series)

$u_i$  represents the random effect assumed to be uncorrelated with the regressors

$\varepsilon_{it}$  represents the residual

# Variables – interpretation

Variable	Interpretation
<b>County house price growth</b>	<ul style="list-style-type: none"> <li>Local house price growth has a strong positive relationship with growth in house prices at the county level. Given the inability of local house prices to effect prices at the county level, the direction of causality runs from the county to local level.</li> </ul>
<b>County house price growth – previous year</b>	<ul style="list-style-type: none"> <li>County house price growth in the previous year drives growth in local house prices in the current year.</li> </ul>
<b>Period after plans made public</b>	<ul style="list-style-type: none"> <li>This variable tests for a significant deviation in the relationship between local and county house price growth in the period after the plans for each of the wind farm sites were announced.</li> </ul>
<b>Period following start of construction</b>	<ul style="list-style-type: none"> <li>This variable tests for a significant deviation in the relationship between local and county house price growth in the period after construction of wind turbines at each site started.</li> </ul>
<b>Period after construction completion</b>	<ul style="list-style-type: none"> <li>This variable tests for a significant deviation in the relationship between local and county house price growth in the period after construction of wind turbines at each site was completed.</li> </ul>

# Validation of results

Test	Purpose of test	Result
<b>Im-Pesaran-Shin unit root test</b>	To determine whether the site average house price variable is stationary i.e. an autoregressive process is present.	Unit root present. Data were converted to house price growth series which was found to be trend stationary. Both the local and county house price growth series were cyclically-adjusted in order to account for this.
<b>Hausman test for fixed v random effects</b>	To determine whether a fixed or random effects estimator is more efficient.	Using the final specification, the random effects estimator was found to be the most efficient.
<b>Wald test for group-wise heteroskedasticity</b>	Heteroskedasticity means a non-constant variance of the residuals. Presence of heteroskedasticity implies that variance may change over the sample resulting false positives and negatives.	Heteroskedasticity was detected. This was controlled for by using robust standard errors that allow for non-constant variance over time.
<b>Lagrange Multiplier test for serial correlation</b>	Serial correlation relates to correlation between the residuals over time. It points to omitted variables and causes the standard errors of the coefficients to be smaller than they actually are.	Serial correlation not detected.
<b>Ramsey RESET test for specification error</b>	This test points to whether non-linear combinations of explanatory variables help explain the dependent variable. Failure to account for this may result in an underestimation of the effect of certain explanatory variables.	None of the variables in the final model specification were found to have a non-linear relationship with local house price growth.



# Glossary

- **Variable:** A variable is any characteristic, number, or quantity that can be measured or counted and relates to the same item. Good examples are unemployment rates, population and interest rates, as well as house prices.
- **Regression analysis:** This describes a statistical procedure or process for estimating the relationships among variables. Regression analysis allows the determination of how one variable changes when one of the variables that are known to influence it are varied, while other influencing variables are held fixed. A regression analysis can be applied to data points from one point in time and also data points that vary over time.
- **House price series:** This describes a sequence of average house prices for specific geographies at different points in time and presented at different frequencies (for example annual, quarterly, and monthly average prices). The most frequently cited house price series for England and Wales are produced by Land Registry, Nationwide and Halifax.
- **Sampling bias:** This describes an error in a data sample caused by the disproportionate or unequal collection of data from groups within a population. In the case of this study, the low number of property transactions for certain housing types at some sites created a persistent error in the sample.
- **Volatility:** In this study, volatility refers to the high variance observed in average house price series which occurs as a result of low numbers of property transactions. This can affect the average in a way that is not considered unacceptable for the purposes of econometric analysis.

# Authorship

This report is a piece of joint research between RenewableUK, the trade body for the wind, wave and tidal industries, and Cebr, leaders in economic forecasts and analysis.

RenewableUK, working in collaboration with their membership, sourced the data for the study and produced the initial analysis.

Cebr provided the econometric analysis, provided interpretation of the data and validated the methodology used throughout the rest of the report.

Find out more:

RenewableUK: [www.renewableuk.com](http://www.renewableuk.com)

Cebr: [www.cebr.com](http://www.cebr.com)



RenewableUK previously: **BWEA**

