The effect of Botley West Solar Farm on local house values

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Summary

- Falls in the value of houses near to utility solar farms are one of several 'externalities' of solar farm construction rarely considered by solar farm developers.
- Although some developers and valuers claim there is no effect, or even a slight increase in the value of houses near to solar farms, more careful studies do reveal an adverse effect.
- The closer to a utility solar farm and the larger the installation, the greater is the adverse impact on house values. Houses in more rural areas are more likely to be affected than those in more urban areas, although it is difficult to quantify this effect.
- The current literature is reviewed and the results of one of the most careful studies, carried out in the Netherlands, is used as a basis for estimating the impact of Botley West Solar Farm (BWSF) on local house prices. The effects found in the Dutch study are likely to be conservative since the solar farms there are of a much smaller size than is BWSF.
- For the present study, BWSF was mapped in Google Earth Pro with a series of buffers at increasing 0.1km distances from the solar farm footprint, up to a maximum of 1.5kms.
- The numbers of houses of several distinct types - detached, semi-detached and terraced - within each 0.1km buffer were counted using the high-resolution imagery of Google Earth. In addition, larger properties were separately counted; those with and without tennis courts and/or swimming pools and larger estates. Farms with and without housing, industrial and other sites were also counted but were not included in calculating externalities. A total of just under 11,000 properties of all types was counted to a maximum distance of 1.5 kms from all BWSF sites. This is likely to be an under-estimate of the total number of properties since the number of units in small blocks of flats could not be estimated from the Google Earth imagery.
- The market values of houses of the three main types (detached, semi-detached and terraced) were derived from the most recent Office of National Statistics tables which include information on median house values from December 1995 to June 2022. Figures are given for each of Oxfordshire's Districts separately. Trends in house prices over that period appear to be linear and were extrapolated to predict values at January 2027, the expected commission date for BWSF, and January 2067, the expected de-commissioning date for BWSF.
- The value of all houses (at January 2027 median values) within each 0.1km buffer was then calculated, up to the maximum 1.5 kms distance. The total value of all properties is over £4.9 billion.
- Using the Dutch results the estimated total loss in house values at January 2027 due to the construction of BWSF is £153.1 million, approximately 3.1% of the total value of all properties, or an average loss of £14,115 per property.
- Houses near to BWSF will be more affected than those farther away. The calculated loss per detached property at a distance of 0.1 kms from BWSF is £40,475. This falls to £29,240 at 0.5 kms and £8,440 at 1.5kms. Comparable figures for semi-detached houses are £27,145, £19,590 and £5,620 respectively; and for terraced houses are £24,467, £17,513 and £5,046 respectively.
- Future buyers might be more reluctant to consider houses near to solar farms; thus house values may not rise as much in the future. This effect has not been quantified to date. Assuming that the impact on future values is only one tenth of that on current values adds a further £15.9 million future loss to the total losses at January 2027; present and future

losses then total £169.0 million. The 'future loss' reduces the expected increase in detached house values closest to the solar farm from £1,248.9 per month to £1,240.2 per month, a difference of only £8.7 per month, just over £100 per year. It is likely that real losses will be greater than this, reflecting purchasers' greater unwillingness to buy houses near to the solar farm.

- A crude sensitivity analysis was carried out by varying the impact on values closest to the solar farm (keeping the impact at 1.5kms constant). With a 10% maximum impact, immediate losses are £203.4 million. With a 15% maximum impact, losses rise £294.2 million.
- Future losses depend on the maximum impact loss assumed and the fraction of that loss curve applied to the increase in house prices between 2027 and 2067. Assuming a 10% immediate impact and 0.1 fractional future impact, future losses are £21.1 million, making a total of present and future losses of £224.5 million. Assuming a 15% immediate impact and the same fractional loss, future losses rise to £30.6 million, making a total loss of £324.8 million. Assuming a 0.2 fractional future impact on the original model (i.e. a -7.22% immediate impact), future losses are £31.8 million (present losses remain the same). Assuming a 0.30 fractional impact, future losses rise to £47.7 million. At this level, the additional loss (between 2027 and 2067) per detached house closest to the farm rises to £26.1 per month (compared with an expected increase of £1248.9 per month in the absence of the solar farm).
- The estimated cost of building BWSF is in excess of £500 million. The strike price for Solar PV energy in England in 2022 was £45.99 per MWh. Botley West's c. 840,000 MWh output per year could thus generate a guaranteed minimum of £38.6 million revenue p.a. if it takes part in the Govt's Contract for Difference (CfD) program that effectively guarantees this minimum figure. Since market prices now exceed strike prices (considerably more so during the current energy crisis) it is likely BWSF will opt not to take part in the CfD scheme (in which any excess above the strike price must be paid back into the scheme). The figure above is therefore the minimum likely annual revenue figure.
- Detailed information on the analyses presented here are given in Annex A and a review of the current literature in Annex B. The review shows that Botley West stands out globally from all the examples given in potentially affecting many thousand times more houses around a single solar installation than in any American study and almost 30 times more houses than in a recent study of all Dutch solar farms.
- Losses in real estate values are genuine externalities of Solar PV installations. Losses in amenity value, that is, the health and welfare benefits of walking in green spaces, are difficult to estimate, but are additional externalities.
- The question now arises; "Who pays when private benefits involve public losses?"

Introduction

The impact of utility scale renewable energy installations on house prices locally is a subject of increasing interest. Such an effect is called an 'externality', the cost (or benefit) of a development not borne (or enjoyed) by the developers. A number of American studies, usually carried out by estate agents, have concluded there is no effect, or even that there is a slight increase in the value of houses near to solar farms (i.e. a positive externality). These studies are based on opinions or past sales without any obvious attempt to compare price changes near to or at some distance from the solar PV installations.

Countering the 'no effect' conclusion is the fact that some solar farm developers in America pay local residents a lump sum on completion of a solar farm nearby and/or an additional monthly payment for the duration of the solar farm, sometimes with the condition that the recipients should not object to the solar farm's development. This suggests a negative externality of the solar farm, because it is unlikely that developers would pay local home-owners purely as a charitable exercise.

Three methods are frequently used in more quantitative studies of solar farm impacts:

a) A direct comparison is made of sale prices of individual houses near to solar farms (the 'test' houses) and of exactly comparable houses (the 'control' houses) at some minimum distance from the solar farms. This is called the 'matched pair' approach. No two houses are exactly comparable, however, and setting the minimum distance is problematic. Too close and 'control' house prices are also likely to be affected; too far and the control houses may fall into a different socio-economic area and therefore are not directly comparable.
b) When the same house is sold several times there are occasions when one of the sales precedes the solar farm installation and another post-dates it. In this case the house remains exactly the same (but for improvements that can be allowed for) and the post-installation price reflects a willingness to pay based on the proximity of the solar farm. This 'sale-resale' approach is obviously the best, but the numbers involved are always small and there are too few examples of the effects on values with distance from the solar farm. In addition, all sale prices need to be adjusted to the house value on the same date by applying local area increases in house prices in the periods between successive sales. Only then are before- and after-solar installation figures directly comparable so that the real effect of the installation can be estimated.
c) The third method involves looking at average or median house prices at different distances from solar farms. This is similar to the matched pair approach but involves collections of houses rather than individual ones. Again, care should be taken to define a minimum distance for 'control' house groups. In the Netherlands, renewable energy farms tend to be in places of low population density and lower socio-economic levels so that house values increase naturally away from such areas even in the absence of the solar farm. Adjustments must be made for these effects.

The effect of solar farms on house prices – the evidence

Annex B reviews much of the current literature on the effect of utility solar photovoltaic (PV) installations on house prices and Figure 1 shows the results. All the results in Annex B are shown in Figure 1 but the following analysis uses only those from the Dutch study of Droes and Koster, shown in red. This study looked at house prices around 107 solar farms dotted about the country, ranging in size from 1 to only 109MW (i.e. less than one tenth the size of BWSF) and opened mostly between 2017 and 2019. The study had data on 1.5 million house sales, 12,650 of them within 1 km of the solar farms present in 2019. Control group houses were chosen between 2 and 5kms away from the solar farms. The value of houses sold within 1km of all solar farms was 4.6% less than that of control group houses (significant at the 1% level). When 'decomposed' into 500m bands, the effect within 500m was -5.9% and between 0.5 and 1 km was – 3.8% (both figures significantly different from zero). There was also a difference of -2% at a distance of 1.5 km but, although following the same trend line, this was not significantly different from zero. This and a final point at 2kms distance define the red line in Figure 1, where the distances are set at the mid-point values in Droes and Koster's study (their Figure 7); thus their 0.5 km figure is plotted at x = 0.25 kms here because the results are for all properties <u>up to</u> 0.5 kms. The best fit regression to these results is a curved line (a polynomial), the fitted line in Figure 1 ($r=0.9994$, $p<0.01$).

The other lines and dots in Figure 1 are from other studies, showing that the Dutch study results are more or less representative, but perhaps under-estimate the effects at smaller distances from solar farms.

In what follows, the Dutch study results are taken as the starting point for estimating the effects of the Botley West Solar Farm on local house prices. Later the effect is examined of changing the intercept of the curve on the y-axis, indicating a greater impact on prices closest to the solar farms. The results are shown in Annex A1. The results of applying an alternative exponential loss curve are examined in Annex A2.

Botley West Solar farm – counting the houses

The Botley West Solar Farm plans were digitised in ArcMap, which was then used to create buffers at increasing 0.1km distances from the edges of the solar farm, out to a maximum of 1.5 kms.

The BWSF map and buffer zones were then imported into Google Earth Pro and the total number of houses within each 0.1 km buffer zone was counted from the detailed satellite imagery of Google Earth, distinguishing detached, semi-detached and terraced houses, substantial larger properties (with or without swimming pools and/or tennis courts), farms with or without on-site residences, industrial areas and others (e.g. allotments). Most houses fell within the first three categories and were easy to identify on the Google Earth imagery. Some larger properties were clearly blocks of flats for which it was impossible to estimate the number of residences. These were included in the 'terraced house' group with an estimate of the number involved, but such properties were few in number and will not greatly affect the overall results.

Larger properties were identified and labelled with Google's 'map pins'. Figure 2 shows the Google Earth view at the end of counting all properties.

A total of 10,964 properties of all types were counted: 3991 detached houses, 3110 semi-detached houses, 3639 terraced houses, 97 'large' houses of one sort or another, 7 estates, 25 farms, 76 industrial sites or units, and 19 'others'.

Botley West Solar farm – the value of the houses

The Office for National Statistics produces datasets of median house prices by quarter and local authority district. The most recent set was produced in December 2022[1] and has data from December 1995 to June 2022. BWSF falls in three Oxon Districts; Cherwell, West Oxford and Vale of White Horse. House values in Cherwell are lower than in the other two Districts which are more similar to each other. Figure 3 shows the changing value of detached houses in each of Oxon's districts since 1995. The overall results are best described by linear fits to the data (shown in Figure 3). The slopes of these regressions therefore represent the average increase in house prices per month. Thus, for example, the value of an Oxford City detached house has been increasing by an average of £2,318.7 per month since 1995. (The linear fit means that increases have been at a decreasing percentage of current prices over the time shown – a perhaps unexpected result given that house price inflation is usually presented as a percentage of current values - something that suggests cumulative or compound increases in prices which clearly did not happen over this period.) Graphs similar to Figure 3 were also produced for semi-detached and terraced houses (Annex A3).

All house value graphs were projected (using the fitted regressions) to the expected values at January 2027, the commissioning date for BWSF, and to January 2067 the de-commissioning date.

For present purposes the BWSF southern-most site – nearest Botley -was considered to fall entirely within Vale of White Horse DC (only a small part of the outermost buffer zones does not) and therefore the Vale house prices were applied to all the houses counted there. The BWSF and buffer zones of the northern and middle sites fall in both Cherwell and West Oxon DCs (with rather different house values). 27% of all buffer zones of those sites fall in Cherwell and the remainder mostly in West Oxon, again with a small amount of the outer buffer zones falling in Vale of White Horse. When house prices were calculated, it was assumed that 27% of all houses in the top two sections of BWSF are in Cherwell and the remainder in West Oxfordshire.

The total value of all houses in each buffer zone was calculated by applying the District Council ONS value to the house type recorded. For valuation purposes, large houses (of both sorts) and estates were treated as 'detached' (i.e. were under-valued). All other properties (mostly farms) were not given any value because it was considered that farmers' attitudes to solar farms might be different from those of house owners.

The 0.1km buffer zone nearest to BWSF had the smallest total number of properties (270), while that at 1.2 to 1.3 kms had the largest number (1218). Numbers tended to increase with distance from the solar farm as more populous communities (Eynsham, Kidlington, Botley etc.) were included (a graph of cumulative numbers is shown in Annex B, Figure B4).

The estimated total January 2027 value of all houses out to 1.5 kms was £4,914,049,693, i.e. almost £5 billion. By January 2067 this is predicted to rise to £10,022,327,777.

The impact of Botley West Solar farm on house values

The first estimate of the impacts of BWSF on house values uses the Dutch result shown in Figure 1 (the red curve). The % impact on house prices was calculated from the fitted curve at the mid-point of each 0.1km buffer (thus x = 0.05kms for the first buffer, x = 0.15kms for the second buffer and so on) and applied to the different values of the different sorts of houses in each local authority district. Totals were calculated by house type and buffer zone and finally summed across all 15 buffers out to 1.5kms. The total loss is £153,059,657, an average loss per property across all properties and distances of £13,960. These losses are obviously greatest for properties nearest to the solar farm; £40,475 for detached houses, £27,145 for semi-detached houses and £24,467 for terraced houses within 0.1 kms of BWSF. Up to 0.4kms away from BWSF, losses are greater than £31,000 for all detached properties, £21,000 for all semi-detached and £19,000 for all terraced houses, and fall to £8,400, £5,600 and £5,000 respectively at 1.5 kms.

Figure 1 suggests that losses close to solar farms may be greater than those in the Dutch study. What is the effect of changing the impact at such short distances? This was investigated by varying the maximum impact (i.e. at 0kms distance) while keeping the same value of the effect at a distance of 1.5kms (i.e. the impact curve is always constrained to pass through the same value at 1.5 kms, which is -1.31%, the fitted value in Figure 1). This ensures that the effect extinguishes at more or less the same distance regardless of its impact just next to the solar farm.

When the maximum impact was set to -10%, the total losses rose to £203.4 million, with losses per property closest to the solar farm of £56,066 (detached), £37,601 (semi-detached) and £33,892 (terraced); at -15% the total losses were £294.2 million, with individual property type losses of £84,183, £56,458 and £50,889 respectively.

The impact of Botley West Solar farm on future increases in house values

Just as a solar farm affects the present-day value of a house, so the farm's presence might affect the future sale value. Buyers in future may be more reluctant to buy a house near to a solar farm so that the future increases in value of such houses may be less than that of houses unaffected by the solar farm.

There is no literature on the quantitative impact of solar farms on future house values. One might expect, for example, that once the immediate fall in house value takes effect (i.e. on solar farm commissioning) the future rise in value will be at a slower rate than indicated by the regressions of house prices against time shown in Figure 3.

One way of calculating this effect is to apply a version of the effects on house values of solar farms shown in Figure 1 to the expected increase in house prices (between Jan 2067 and January 2027) that would have taken place in the absence of the solar farm. This was done by applying a fixed fraction of the effects/distance graph of Figure 1. For example, a fraction of 0.1 means that a 5% decrease in Fig. 1 becomes a 0.5% decrease applied to the predicted increase in house prices between 2027 and 2067. And so on for the effects at all distances shown in Figure 1.

Applying a 0.1 fraction results in a total additional loss of £15.9 million, or an average of £1,468 per property (of all types), which is just 0.16% of the predicted 2067 value in the absence of BWSF. (Details of three models using maximum impact figures of -7.2275%, -10% and -15% and a 0.1 fraction for the 2027 to 2067 increase in house values are given in Annex A1). Increasing the fraction to 0.2 causes the additional loss to rise to £31.8 million (mean loss of £2,935 per property); and to 0.3 causes the additional loss to rise to £47.7 million (mean loss of £4,403 per property). Even this highest value represents a loss of only 0.48% of the expected 2067 value of the properties near to BWSF, or of just £9.17 per month for the 40-year duration of BWSF.

The above results are gathered together in Table 1 (upper half) for direct comparison, with additional details for some models in Annex A1.

An alternative exponential model was examined to see how losses vary with the type of loss curve used. Although a polynomial model is the best fit to the Droes & Koster data, more rapid changes might be expected nearer to solar farms, as indicated by the other data in Figure 1. The exponential model results are given in Table 1 (lower half) and Annex A2.

Predicted costs and revenues of BWSF

In this section we examine the likely costs and revenues to the developers of BWSF, PhotoVolt Development Partners (PVDP).

During the developers' seminar in December 2022, a PVDP representative estimated the cost of constructing BWSF at 'about £500 million'. This would make it considerably cheaper per installed MW than PVDP's 480 MW Solar PV installation on Ukujima Island in Japan which was costed at about €1.48 billion in 2012 (but also involved an expensive undersea cable linking to the mainland), but it would not be that much cheaper than the 2020/21 estimated costs of utility solar PV in the USA of $0.82 per installed W_{DC}. Building BWSF's 1100MW installation using this American rate would thus cost $902 million, or about £745 million; this figure drops to £569 million if BWSF is assumed to install only the 840MW capacity it is contracted to deliver to the National Grid). Solar panel prices have fallen by more than 80% in the last 10 years, so these figures are nominal only.

It is difficult to find the price at which utility scale solar PV developers sell their electricity to the grid. The nearest we can come to this is the strike price in the UK Government's Contracts for Difference (CfD) scheme that guarantees a minimum payment for energy from renewable sources. If the market price is lower than the strike price, the Government makes up the difference to the suppliers. If it is greater than the strike price then the suppliers pay the Government the excess over the strike price.

The strike price for solar PV during the most recent round of bids was £45.99 per MWh, which implies a guaranteed income for BWSF, should it join the CfD scheme, of £38.6 million p.a. (assuming delivery of 840,000 MWh by BWSF to the National Grid, the contracted figure). The BWSF literature claims a total delivery of 1,256,539 MWh to the grid – numbers that it has not been able to explain in a series of emails – which would indicate a revenue of £57.8 million p.a.

There are two reasons why PVDP may choose not to join the CfD scheme. First, BWSF benefits from economies of scale; the cost per installed MW tends to fall with increasing size. In BWSF's case it also has the benefit that the National Grid will pay for and install the new substation required to connect BWSF to the grid. Second, electricity prices are currently high – the market price is higher than the strike price - in which case suppliers do better if they do <u>not</u> join the CfD scheme, because they do not have to return any excess over the strike price to the Government.

With low installation costs (per MW) and high market prices, suppliers do best staying in the market place and retaining all profits from the electricity they generate. Thus, the annual revenue figures above are probably minimal estimates for PVDP's income from BWSF.

With an initial installation cost of c. £500 million, yearly maintenance and rental costs of several tens of millions and annual revenues of c. £50 million, it will take PVDP and its partners at least 10 years to 'break even', after which, for the next 30 years, most annual revenue is profit.

Striking the balance between private gains and public losses

Compared with the cost and revenue figures for BWSF, the £170 million to £200+ million reduction in the value of houses near BWSF is a significant externality of the solar farm proposal that has not yet been acknowledged either by the developers or by the affected District Councils.

Government guidance on determining a planning application[2] states (para. 008) that authorities should take into account 'material considerations' when deciding on an application

"A material planning consideration is one which is relevant to making the planning decision in question (eg whether to grant or refuse an application for planning permission).

The scope of what can constitute a material consideration is very wide and so the courts often do not indicate what cannot be a material consideration. However, in general they have taken the view that planning is concerned with land use in the public interest, so that <u>the protection of purely private interests such as the impact of a development on the value of a neighbouring property or loss of private rights to light could not be material considerations."</u> (author's emphasis)

The next paragraph (009) then asks the question 'What weight can be given to a material consideration?'

"The law makes a clear distinction between the question of whether something is a material consideration and the weight which it is to be given. Whether a particular consideration is material will depend on the circumstances of the case and is ultimately a decision for the courts. Provided regard is had to all material considerations, it is for the decision maker to decide what weight is to be

given to the material considerations in each case, and (subject to the test of reasonableness) the courts will not get involved in the question of weight."

These paragraphs seem designed to dismiss as 'unimportant' the impact of a development on the value of a very small number of neighbouring properties. Botley West would affect almost 11,000 properties to a greater or lesser extent. This surely constitutes a 'material consideration' that cannot be ignored?

Figure 1. Relationship between the percentage change in house values with distance from solar farms from a number of different studies (details in Annex B). Negative changes indicate a fall in house values. The red symbols and fitted line refer to the Dutch study by Droes and Koster which forms the basis for many of the calculations in this report ($y = -x^2 + 5.55x - 7.2275$, $r = 0.9994$). The first two points on the graph are significantly different from 0 but the others are not.

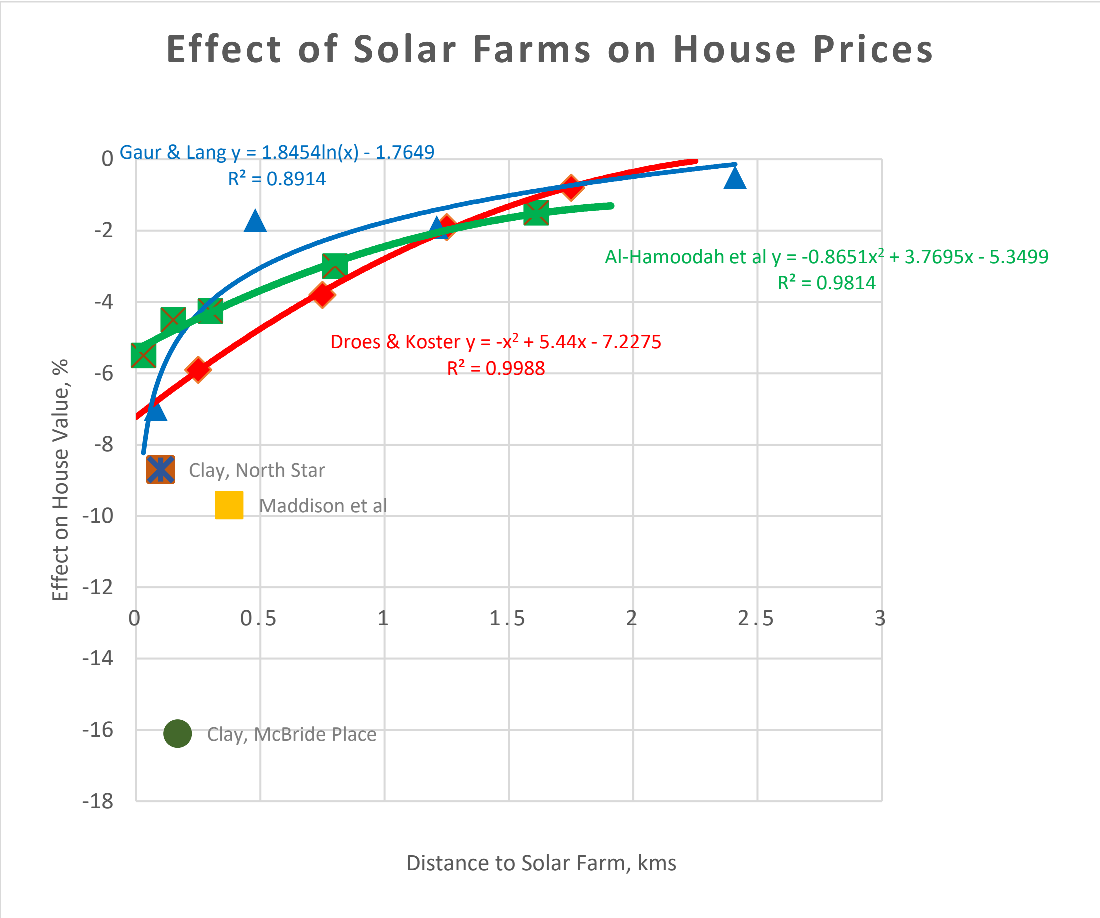


Figure 2. Google Earth image of the Botley West Solar Farm (in red) with 0.1 kms buffers (different colours) out to a maximum distance of 1.5 kms. The total numbers of houses of different types were counted within each 0.1km buffer. Map 'pins' and labels indicate properties of particular types (large houses, farms etc.).

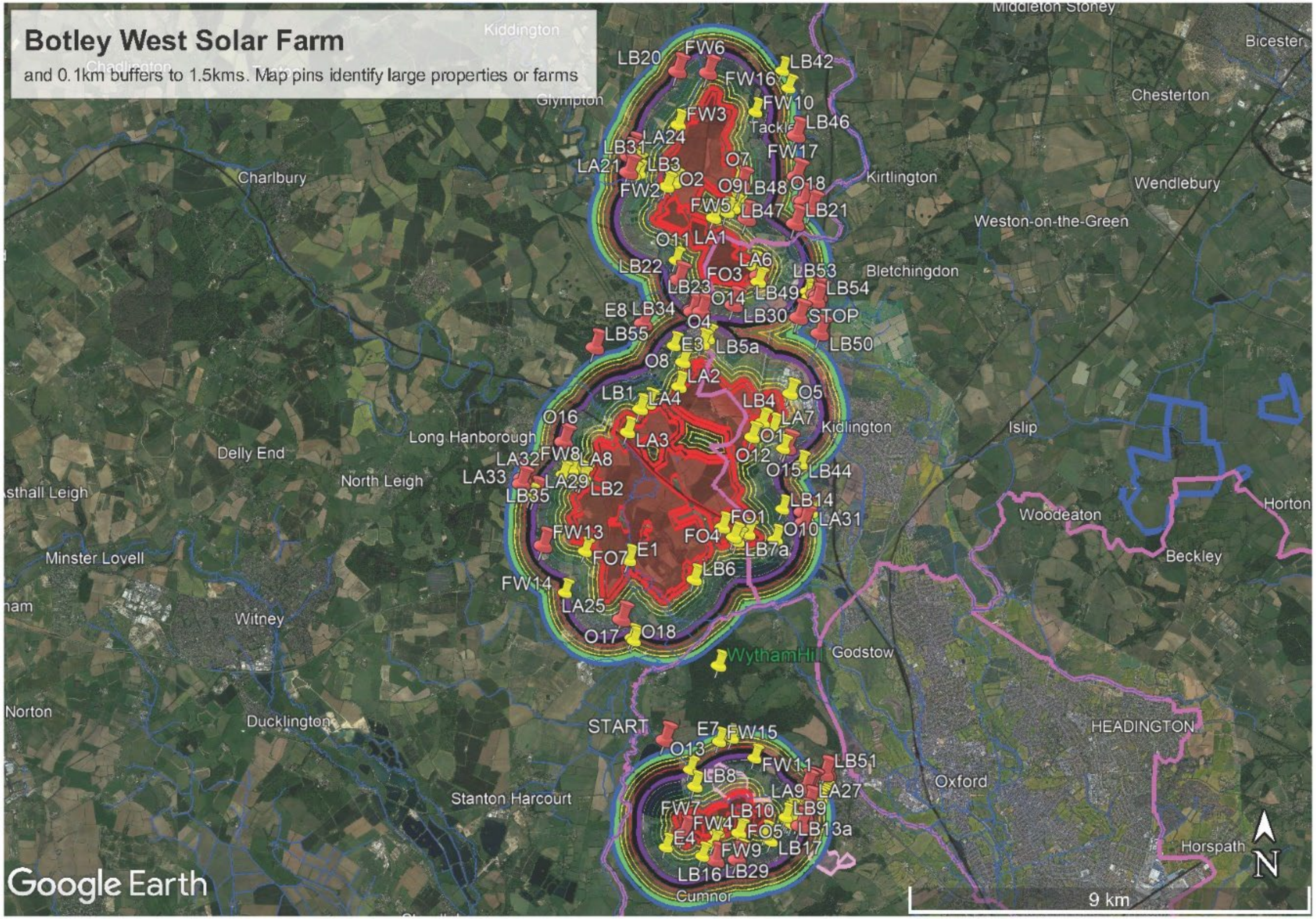


Figure 3. Increase in detached house median values in Oxfordshire's various districts since January 1995 (=0 on the x-axis). The slopes of the best fit linear regressions (the best description of the data) indicate the increase in house values per month. Original data from ONS[1]. See Annex A3 for other house types, and for percentage changes/quarter in house values over time.

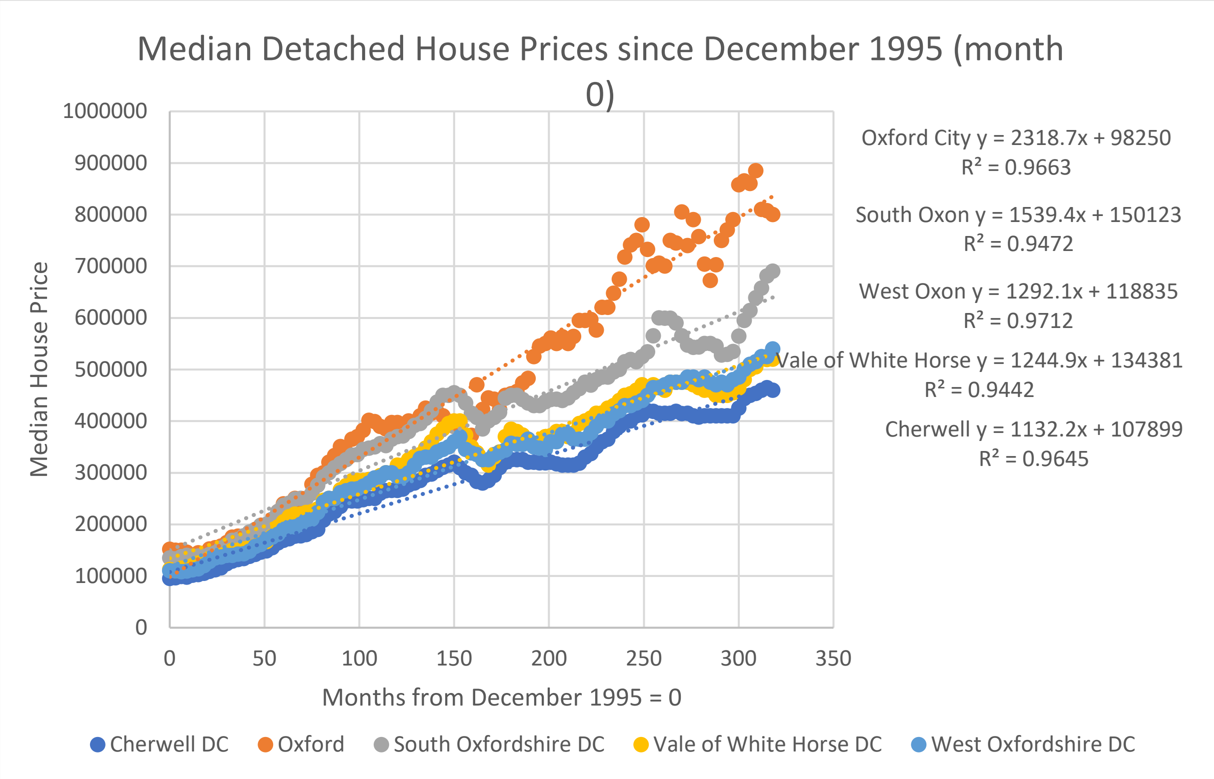
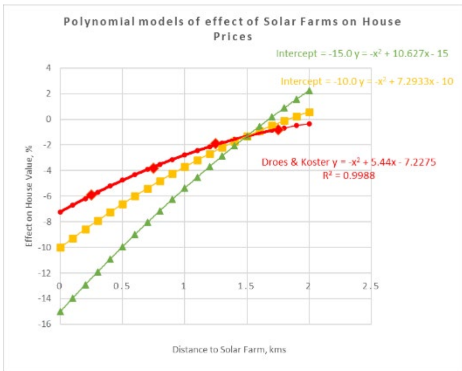


Table 1. Summary of all results. 'Model Intercept' is the value of the Droes & Koster-type curve in Figure 1 at a distance of of0kms; 'Fractional impact….' is the fraction of this curve that applies to the increase in house values between 2027 and 2067; 'Immediate loss…' is the total loss in value of all houses around BWSF at January 2027 (the commission date of BWSF); 'Additional losses…' are extra losses between 2027 and 2067. 'Total….' is the sum of both of these figures and 'Average..' is the average loss to all 10,844 properties within 1.5 kms of BWSF. Annexes A1 and A2 contain more details of the results in bold here.

Model type	Model Intercept	Fractional impact on the 2027-2067 expected increase in house values	Immediate loss in values, January 2027	Additional losses, 2027 to 2067	Total (immediate and future) losses	Average loss/property, all property types at all distances to 1.5kms
Polynomial	**-7.23%**	**0.1**	**-£153,059,657**	**-£15,914,075**	**-£168,973,732**	**-£15,582**
		0.2	-£153,059,657	-£31,828,151	-£184,887,808	-£17,050
		0.3	-£153,059,657	-£47,742,226	-£200,801,883	-£18,517
	-10%	**0.1**	**-£203,396,525**	**-£21,146,785**	**-£224,543,311**	**-£20,707**
		0.2	-£203,396,525	-£42,293,570	-£245,690,096	-£22,657
		0.3	-£203,396,525	-£63,440,356	-£266,836,881	-£24,607
	-15%	**0.1**	**-£294,175,368**	**-£30,583,593**	**-£324,758,961**	**-£29,948**
		0.2	-£294,175,368	-£61,167,186	-£355,342,554	-£32,769
		0.3	-£294,175,368	-£91,750,779	-£385,926,147	-£35,589
Exponential	**-7.23%**	**0.1**	**-£133,699,088**	**-£13,904,032**	**-£147,603,121**	**-£13,612**
		0.2	-£133,699,088	-£27,808,065	-£161,507,153	-£14,894
		0.3	-£133,699,088	-£41,712,097	-£175,411,186	-£16,176
	-10%	**0.1**	**-£157,384,217**	**-£16,369,865**	**-£173,754,082**	**-£16,023**
		0.2	-£157,384,217	-£32,739,729	-£190,123,947	-£17,533
		0.3	-£157,384,217	-£49,109,594	-£206,493,811	-£19,042
	-15%	**0.1**	**-£195,124,645**	**-£20,300,149**	**-£215,424,794**	**-£19,866**
		0.2	-£195,124,645	-£40,600,299	-£235,724,944	-£21,738
		0.3	-£195,124,645	-£60,900,448	-£256,025,093	-£23,610

Annex A1. Effect of different maximum impacts on house values – polynomial models.



Intercept = -7.2275% (Droes & Koster)

Polynomial models with different intercepts (=maximum impact at a distance of 0kms). The Droes & Koster curve is shown in red in the graph (left), with three alternative lines corresponding to intercepts of -7.2275 (i.e. as observed), -10% and -15%, all constrained to give a value of -1.31% at 1.5kms (the Droes & Koster fitted value).

The Tables below show total number of houses, value of those houses at January 2027, total losses in values for all houses to 1.5kms at January 2027, value of all houses at January 2067 in the absence of BWSF, additional losses to all houses between January 2027 and January 2067 (assuming additional losses are 0.1 of the values in the graphs, left), and January 2027 losses per property related to distance from BWSF. Totals for all property types at all distances are in red in the right-hand column.

Property type		Detached	Semi-detached	Terraced	Large det1	Large det2	Estate	Farm with	Farm without	Industrial	Other	
Sum n (total houses) to 1.5km		**3991**	**3110**	**3639**	**37**	**60**	**7**	**18**	**7**	**76**	**19**	**10,844**
Total Value all buffers, Jan 27, ££		**2,348,156,595**	**1,224,814,359**	**1,279,745,761**	**21,864,023**	**35,362,837**	**4,106,118**	**0**	**0**	**0**	**0**	**£4,914,049,693**
Total loss all buffers, Jan 27, ££		**-73,748,385**	**-39,193,038**	**-37,823,136**	**-934,345**	**-1,204,990**	**-155,763**					**-£153,059,657**
Total Value all buffers, Jan 67, ££		**4,737,691,452**	**2,526,878,522**	**2,634,173,104**	**44,006,307**	**71,279,745**	**8,298,647**	**0**	**0**	**0**	**0**	**£10,022,327,777**
Total loss all buffers, Jan 67, ££		**-7,512,145**	**-4,165,994**	**-4,003,057**	**-94,602**	**-122,357**	**-15,921**					**-£15,914,075**
Loss per property in buffer km	**0.1**	-40,475	-27,145	-24,467	-40,475	-40,475	-40,475					-£1,468
	0.2	-37,424	-25,099	-22,622		-37,424		**Estimated total loss to Jan67, ££**				**-£168,973,732**
	0.3	-34,602	-23,685	-20,848	-35,497	-34,489						
	0.4	-31,836	-21,496	-19,148	-31,671	-32,596						
	0.5	-29,240	-19,590	-17,513	-29,815	-29,815						
	0.6	-26,624	-18,000	-15,948	-27,044	-27,154	-26,383					
	0.7	-24,290	-16,255	-14,458	-24,496	-24,333	-24,612					
	0.8	-21,914	-14,683	-13,034	-21,770	-21,875	-21,560					
	0.9	-19,640	-13,116	-11,683	-19,606	-19,662						
	1	-17,448	-11,664	-10,401	-17,203	-17,392	-17,203					
	1.1	-15,409	-10,239	-9,188	-15,643	-15,421	-15,643					
	1.2	-13,468	-9,003	-8,047	-13,311	-13,571						
	1.3	-11,647	-7,810	-6,976		-11,624						
	1.4	-9,965	-6,670	-5,976	-9,885	-9,968	-9,885					
	1.5	-8,440	-5,620	-5,046		-8,346						

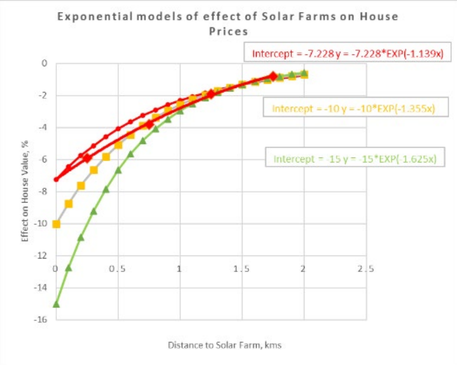
Intercept = -10.0%

Property type		Detached	Semi-detached	Terraced	Large det1	Large det2	Estate	Farm with	Farm without	Industrial	Other	
Sum n (total houses) to 1.5km		**3991**	**3110**	**3639**	**37**	**60**	**7**	**18**	**7**	**76**	**19**	**10,844**
Total Value all buffers, Jan 27, ££		**2,348,156,595**	**1,224,814,359**	**1,279,745,761**	**21,864,023**	**35,362,837**	**4,106,118**	**0**	**0**	**0**	**0**	**£4,914,049,693**
Total loss all buffers, Jan 27, ££		**-98,251,964**	**-52,265,858**	**-49,762,252**	**-1,284,581**	**-1,620,325**	**-211,546**					**-£203,396,525**
Total Value all buffers, Jan 67, ££		**4,737,691,452**	**2,526,878,522**	**2,634,173,104**	**44,006,307**	**71,279,745**	**8,298,647**	**0**	**0**	**0**	**0**	**£10,022,327,777**
Total loss all buffers, Jan 67, ££		**-10,008,547**	**-5,555,420**	**-5,266,636**	**-130,051**	**-164,509**	**-21,623**					**-£21,146,785**
Loss per property in buffer km	**0.1**	-56,066	-37,601	-33,892	-56,066	-56,066	-56,066					-£1,950
	0.2	-51,940	-34,834	-31,397		-51,940		**Estimated total loss to Jan67, ££**				**-£224,543,311**
	0.3	-48,087	-32,915	-28,973	-49,330	-47,930						
	0.4	-44,266	-29,889	-26,623	-44,036	-45,323						
	0.5	-40,635	-27,225	-24,338	-41,435	-41,435						
	0.6	-36,932	-24,969	-22,123	-37,514	-37,667	-36,598					
	0.7	-33,574	-22,467	-19,984	-33,858	-33,632	-34,019					
	0.8	-30,110	-20,176	-17,910	-29,913	-30,057	-29,625					
	0.9	-26,744	-17,860	-15,908	-26,697	-26,774						
	1	-23,446	-15,673	-13,976	-23,117	-23,370	-23,117					
	1.1	-20,315	-13,499	-12,113	-20,623	-20,330	-20,623					
	1.2	-17,275	-11,548	-10,322	-17,075	-17,407						
	1.3	-14,360	-9,629	-8,601		-14,332						
	1.4	-11,591	-7,758	-6,951	-11,498	-11,594	-11,498					
	1.5	-8,984	-5,981	-5,371		-8,884						

Intercept = -15.0%

Property type		Detached	Semi-detached	Terraced	Large det1	Large det2	Estate	Farm with	Farm without	Industrial	Other	
Sum n (total houses) to 1.5km		**3991**	**3110**	**3639**	**37**	**60**	**7**	**18**	**7**	**76**	**19**	**10,844**
Total Value all buffers, Jan 27, ££		**2,348,156,595**	**1,224,814,359**	**1,279,745,761**	**21,864,023**	**35,362,837**	**4,106,118**	**0**	**0**	**0**	**0**	**£4,914,049,693**
Total loss all buffers, Jan 27, ££		**-142,442,366**	**-75,841,728**	**-71,293,570**	**-1,916,206**	**-2,369,351**	**-312,146**					**-£294,175,368**
Total Value all buffers, Jan 67, ££		**4,737,691,452**	**2,526,878,522**	**2,634,173,104**	**44,006,307**	**71,279,745**	**8,298,647**	**0**	**0**	**0**	**0**	**£10,022,327,777**
Total loss all buffers, Jan 67, ££		**-14,510,624**	**-8,061,148**	**-7,545,408**	**-193,981**	**-240,527**	**-31,905**					**-£30,583,593**
Loss per property in buffer km	**0.1**	-84,183	-56,458	-50,889	-84,183	-84,183	-84,183					-£2,820
	0.2	-78,118	-52,390	-47,221		-78,118		**Estimated total loss to Jan67, ££**				**-£324,758,961**
	0.3	-72,405	-49,560	-43,625	-74,277	-72,169						
	0.4	-66,682	-45,025	-40,106	-66,336	-68,274						
	0.5	-61,186	-40,994	-36,646	-62,391	-62,391						
	0.6	-55,522	-37,537	-33,259	-56,397	-56,627	-55,019					
	0.7	-50,316	-33,670	-29,950	-50,742	-50,404	-50,983					
	0.8	-44,892	-30,080	-26,702	-44,598	-44,813	-44,168					
	0.9	-39,554	-26,415	-23,528	-39,485	-39,599						
	1	-34,263	-22,904	-20,424	-33,782	-34,152	-33,782					
	1.1	-29,161	-19,377	-17,387	-29,604	-29,184	-29,604					
	1.2	-24,142	-16,138	-14,425	-23,862	-24,326						
	1.3	-19,252	-12,910	-11,532		-19,215						
	1.4	-14,523	-9,721	-8,709	-14,407	-14,527	-14,407					
	1.5	-9,965	-6,634	-5,957		-9,854						

Annex A2. Effect of different maximum impacts on house values – exponential models.



Intercept = -7.2275% (Droes & Koster)

Exponential models with different intercepts (=maximum impact at a distance of 0kms). The Droes & Koster curve is shown in red in the graph (left), with three alternative lines corresponding to intercepts of -7.2275 (i.e. as observed), -10% and -15% all constrained to give a value of -1.31% at 1.5kms (the Droes & Koster fitted value).

The Tables below show total number of houses, value of those houses at January 2027, total losses in values for all houses to 1.5kms at January 2027, value of all houses at January 2067 in the absence of BWSF, additional losses to all houses between January 2027 and January 2067 (assuming additional losses are 0.1 of the values in the graphs, left), and January 2027 losses per property related to distance from BWSF. Totals for all property types at all distances are in red in the right-hand column.

Property type		Detached	Semi-detached	Terraced	Large det1	Large det2	Estate	Farm with	Farm without	Industrial	Other	
Sum n (total houses) to 1.5km		**3991**	**3110**	**3639**	**37**	**60**	**7**	**18**	**7**	**76**	**19**	**10,844**
Total Value all buffers, Jan 27, ££		**2,348,156,595**	**1,224,814,359**	**1,279,745,761**	**21,864,023**	**35,362,837**	**4,106,118**	**0**	**0**	**0**	**0**	**£4,914,049,693**
Total loss all buffers, Jan 27, ££		**-64,219,635**	**-34,154,033**	**-33,323,549**	**-814,730**	**-1,050,015**	**-137,127**					**-£133,699,088**
Total Value all buffers, Jan 67, ££		**4,737,691,452**	**2,526,878,522**	**2,634,173,104**	**44,006,307**	**71,279,745**	**8,298,647**	**0**	**0**	**0**	**0**	**£10,022,327,777**
Total loss all buffers, Jan 67, ££		**-6,543,429**	**-3,630,516**	**-3,526,882**	**-82,521**	**-106,663**	**-14,022**					**-£13,904,032**
Loss per property in b	**0.1**	-39,718	-26,637	-24,009	-39,718	-39,718	-39,718					-£1,282
	0.2	-35,444	-23,770	-21,425		-35,444		**Estimated total loss to Jan67, ££**				**-£147,603,121**
	0.3	-31,733	-21,721	-19,120	-32,554	-31,629						
	0.4	-28,373	-19,158	-17,065	-28,226	-29,050						
	0.5	-25,424	-17,034	-15,227	-25,924	-25,924						
	0.6	-22,683	-15,335	-13,587	-23,040	-23,134	-22,478					
	0.7	-20,375	-13,634	-12,128	-20,547	-20,410	-20,645					
	0.8	-18,193	-12,191	-10,821	-18,074	-18,161	-17,900					
	0.9	-16,235	-10,842	-9,657	-16,207	-16,254						
	1	-14,458	-9,665	-8,618	-14,255	-14,411	-14,255					
	1.1	-12,896	-8,569	-7,690	-13,092	-12,906	-13,092					
	1.2	-11,485	-7,677	-6,862	-11,352	-11,573						
	1.3	-10,224	-6,856	-6,124		-10,204						
	1.4	-9,113	-6,100	-5,465	-9,040	-9,115	-9,040					
	1.5	-8,158	-5,431	-4,877		-8,067						

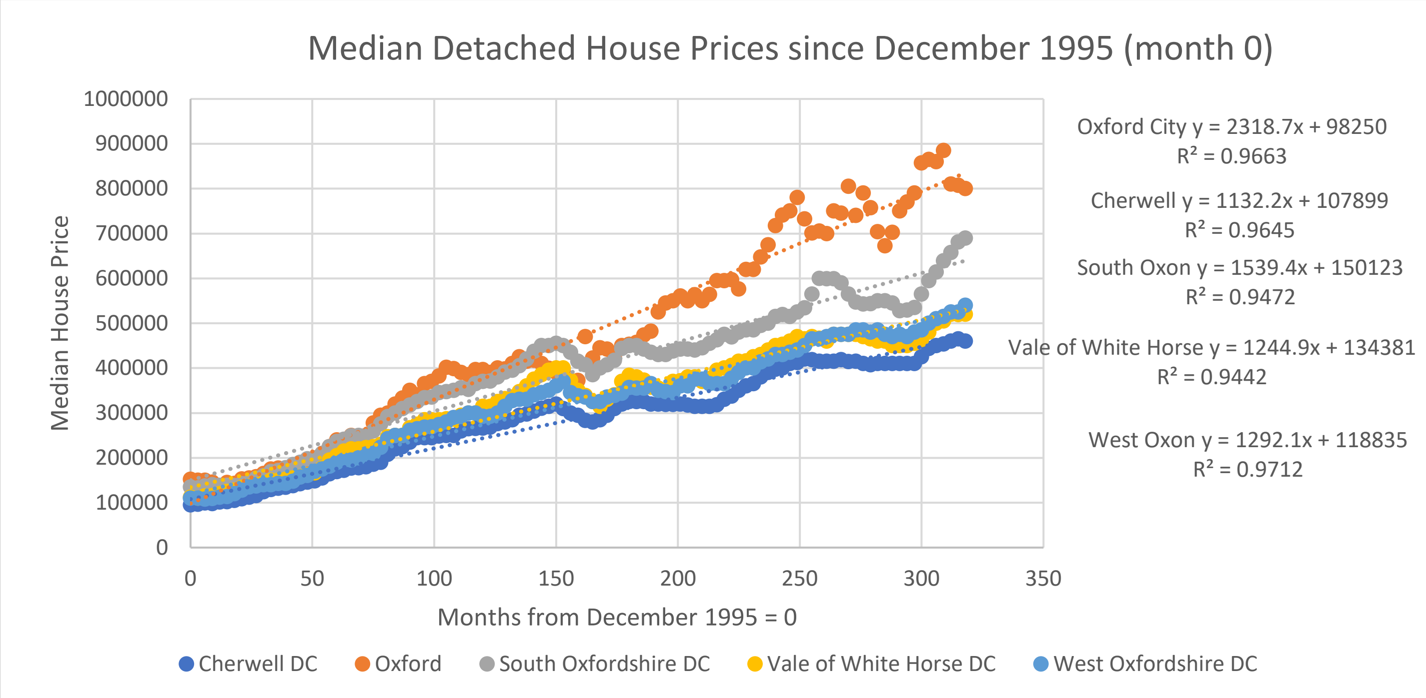
Intercept = -10.0%

Property type		Detached	Semi-detached	Terraced	Large det1	Large det2	Estate	Farm with	Farm without	Industrial	Other	
Sum n (total houses) to 1.5km		**3991**	**3110**	**3639**	**37**	**60**	**7**	**18**	**7**	**76**	**19**	**10,844**
Total Value all buffers, Jan 27, ££		**2,348,156,595**	**1,224,814,359**	**1,279,745,761**	**21,864,023**	**35,362,837**	**4,106,118**	**0**	**0**	**0**	**0**	**£4,914,049,693**
Total loss all buffers, Jan 27, ££		**-75,579,780**	**-40,339,668**	**-39,036,196**	**-1,006,686**	**-1,254,219**	**-167,669**					**-£157,384,217**
Total Value all buffers, Jan 67, ££		**4,737,691,452**	**2,526,878,522**	**2,634,173,104**	**44,006,307**	**71,279,745**	**8,298,647**	**0**	**0**	**0**	**0**	**£10,022,327,777**
Total loss all buffers, Jan 67, ££		**-7,703,721**	**-4,288,047**	**-4,131,532**	**-101,982**	**-127,432**	**-17,151**					**-£16,369,865**
Loss per property in b	**0.1**	-54,362	-36,458	-32,862	-54,362	-54,362	-54,362					-£1,510
	0.2	-47,473	-31,838	-28,697		-47,473		**Estimated total loss to Jan67, ££**				**-£173,754,082**
	0.3	-41,593	-28,470	-25,060	-42,669	-41,457						
	0.4	-36,393	-24,573	-21,888	-36,204	-37,261						
	0.5	-31,911	-21,380	-19,113	-32,540	-32,540						
	0.6	-27,861	-18,837	-16,690	-28,301	-28,416	-27,609					
	0.7	-24,490	-16,389	-14,577	-24,698	-24,533	-24,815					
	0.8	-21,400	-14,339	-12,729	-21,260	-21,363	-21,055					
	0.9	-18,688	-12,480	-11,116	-18,656	-18,709						
	1	-16,286	-10,887	-9,708	-16,057	-16,233	-16,057					
	1.1	-14,216	-9,446	-8,476	-14,432	-14,227	-14,432					
	1.2	-12,389	-8,282	-7,402	-12,245	-12,484						
	1.3	-10,792	-7,237	-6,464		-10,772						
	1.4	-9,414	-6,301	-5,645	-9,338	-9,416	-9,338					
	1.5	-8,247	-5,491	-4,930		-8,155						

Intercept = -15.0%

Property type		Detached	Semi-detached	Terraced	Large det1	Large det2	Estate	Farm with	Farm without	Industrial	Other	
Sum n (total houses) to 1.5km		**3991**	**3110**	**3639**	**37**	**60**	**7**	**18**	**7**	**76**	**19**	**10,844**
Total Value all buffers, Jan 27, ££		**2,348,156,595**	**1,224,814,359**	**1,279,745,761**	**21,864,023**	**35,362,837**	**4,106,118**	**0**	**0**	**0**	**0**	**£4,914,049,693**
Total loss all buffers, Jan 27, ££		**-93,650,313**	**-50,171,251**	**-48,185,296**	**-1,318,363**	**-1,581,614**	**-217,808**					**-£195,124,645**
Total Value all buffers, Jan 67, ££		**4,737,691,452**	**2,526,878,522**	**2,634,173,104**	**44,006,307**	**71,279,745**	**8,298,647**	**0**	**0**	**0**	**0**	**£10,022,327,777**
Total loss all buffers, Jan 67, ££		**-9,550,394**	**-5,333,190**	**-5,099,930**	**-133,595**	**-160,749**	**-22,291**					**-£20,300,149**
Loss per property in b	**0.1**	-80,449	-53,953	-48,631	-80,449	-80,449	-80,449					-£1,872
	0.2	-68,380	-45,860	-41,335		-68,380		**Estimated total loss to Jan67, ££**				**-£215,424,794**
	0.3	-58,313	-39,914	-35,134	-59,821	-58,122						
	0.4	-49,661	-33,532	-29,868	-49,403	-50,847						
	0.5	-42,385	-28,397	-25,386	-43,219	-43,219						
	0.6	-36,019	-24,352	-21,576	-36,587	-36,736	-35,693					
	0.7	-30,816	-20,622	-18,343	-31,077	-30,870	-31,225					
	0.8	-26,210	-17,562	-15,590	-26,038	-26,164	-25,787					
	0.9	-22,278	-14,877	-13,252	-22,239	-22,303						
	1	-18,896	-12,632	-11,264	-18,631	-18,835	-18,631					
	1.1	-16,055	-10,668	-9,573	-16,298	-16,067	-16,298					
	1.2	-13,618	-9,104	-8,137	-13,460	-13,722						
	1.3	-11,547	-7,743	-6,916		-11,525						
	1.4	-9,804	-6,562	-5,879	-9,725	-9,806	-9,725					
	1.5	-8,359	-5,565	-4,997		-8,266						

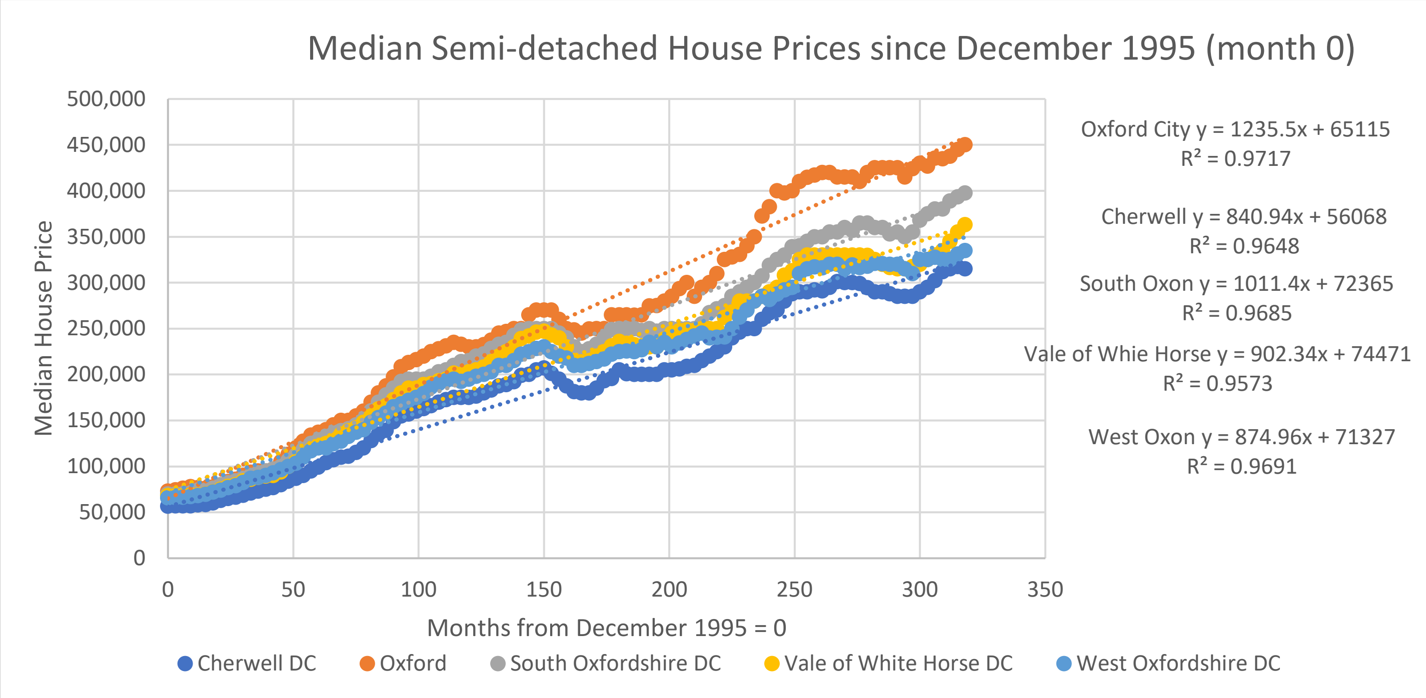
Annex A3. Changing values of Detached houses in Oxfordshire, 1995 to 2022 (also main text, Figure 3)



Detached houses

Local Authority	Value at June 2022	Regression Intercept	Regression Slope	Value at Jan 2027	Value Jan 2067	Increase 2027 to 2067
Cherwell DC	£460,000	£107,899	£1,132	£530,210	£1,073,666	£543,456
Oxford	£800,000	£98,250	£2,319	£963,125	£2,076,101	£1,112,976
South Oxfordshire DC	£690,000	£150,123	£1,539	£724,319	£1,463,231	£738,912
Vale of White Horse DC	£520,000	£134,381	£1,245	£598,729	£1,196,281	£597,552
West Oxfordshire DC	£540,000	£118,835	£1,292	£600,788	£1,220,996	£620,208
Sum CDC, WODC & VOWH	**£1,520,000**			**£1,729,727**	**£3,490,943**	**£1,761,216**
Mean CDC, WODC & VOWH	**£506,667**			**£576,576**	**£1,163,648**	**£587,072**

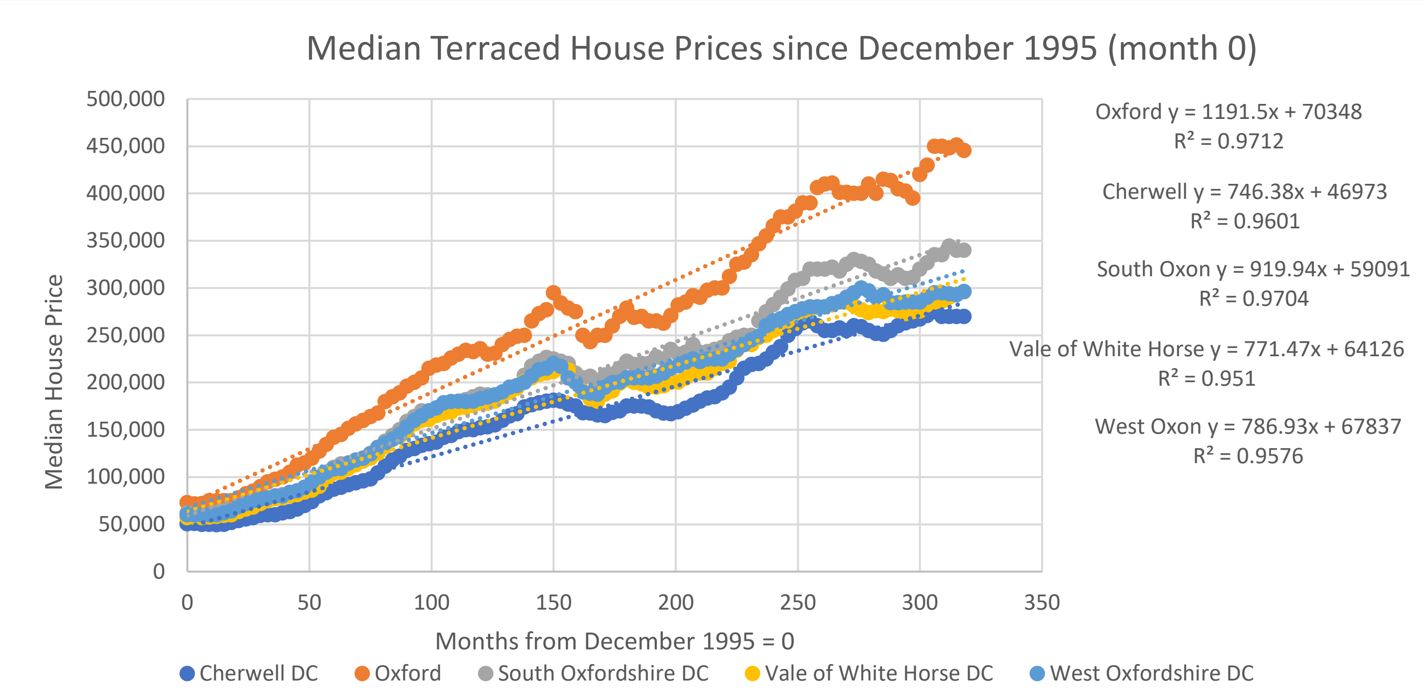
Annex A3 (cont.). Changing values of Semi-detached houses in Oxfordshire, 1995 to 2022



Semi-detached houses

Local Authority	Value at June 2022	Regression Intercept	Regression Slope	Value at Jan 2027	Value Jan 2067	Increase 2027 to 2067
Cherwell DC	£315,000	£56,068	£841	£369,739	£773,390	£403,651
Oxford	£450,000	£65,115	£1,236	£525,957	£1,118,997	£593,040
South Oxfordshire DC	£397,500	£72,365	£1,011	£449,617	£935,089	£485,472
Vale of White Horse DC	£363,250	£74,471	£902	£411,044	£844,167	£433,123
West Oxfordshire DC	£335,000	£71,327	£875	£397,687	£817,668	£419,981
Sum CDC, WODC & VOWH	**£1,013,250**			**£1,178,470**	**£2,435,225**	**£1,256,755**
Mean CDC, WODC & VOWH	**£337,750**			**£392,823**	**£811,742**	**£418,918**

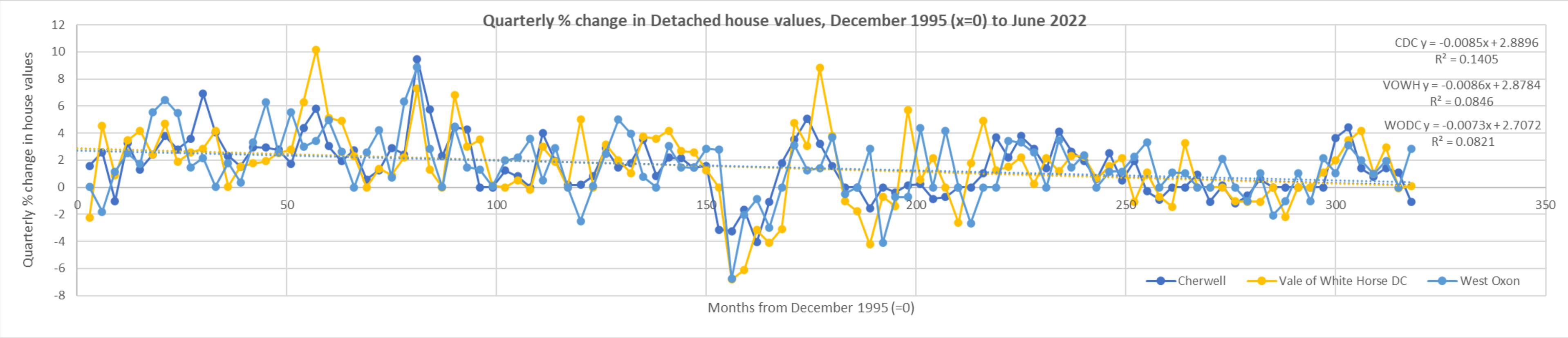
Annex A3 (cont.). Changing values of Terraced houses in Oxfordshire, 1995 to 2022

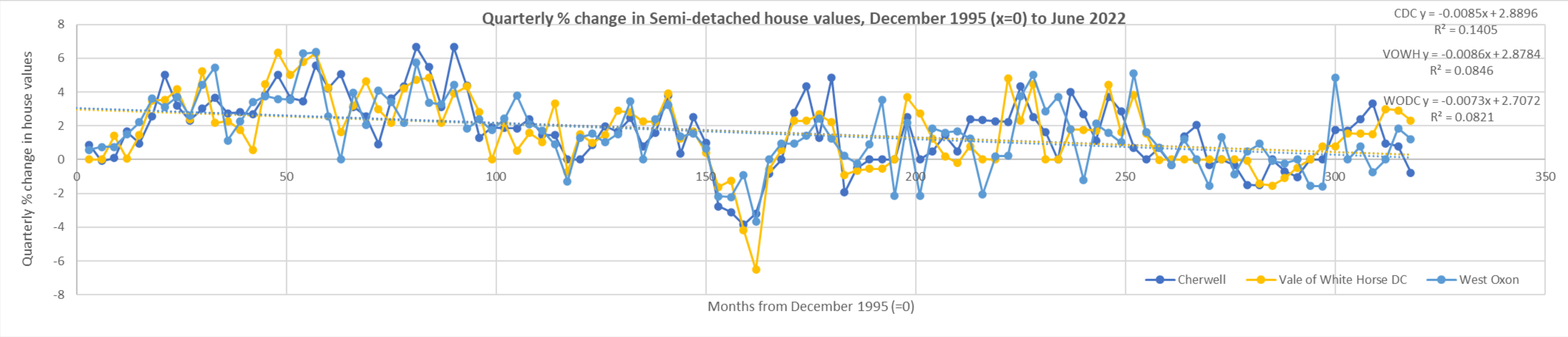


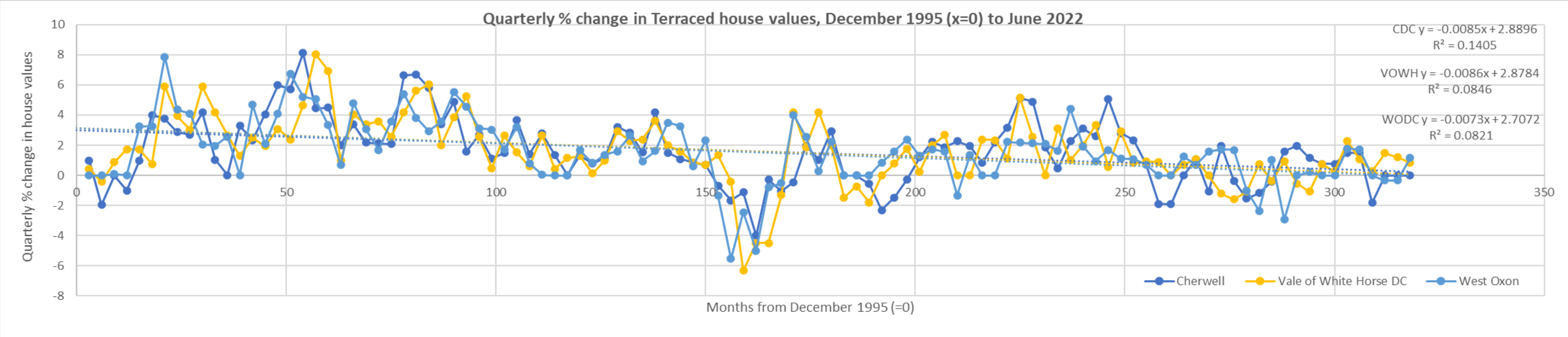
Terraced houses

Local Authority	Value at June 2022	Regression Intercept	Regression Slope	Value at Jan 2027	Value Jan 2067	Increase 2027 to 2067
Cherwell DC	£270,000	£46,973	£746	£325,373	£683,635	£358,262
Oxford	£445,388	£70,348	£1,192	£514,778	£1,086,698	£571,920
South Oxfordshire DC	£340,000	£59,091	£920	£402,229	£843,800	£441,571
Vale of White Horse DC	£296,000	£64,126	£771	£351,884	£722,190	£370,306
West Oxfordshire DC	£296,400	£67,837	£787	£361,362	£739,088	£377,726
Sum CDC, WODC & VOWH	**£862,400**			**£1,038,619**	**£2,144,913**	**£1,106,294**
Mean CDC, WODC & VOWH	**£287,467**			**£346,206**	**£714,971**	**£368,765**

Annex A4. Quarterly percentage change in house prices. The linear slopes of house price increases (shown in Annex A3) imply a decreasing percentage change in house values over time. Notice the significant negative slopes ($p<0.005$) in all graphs here.







Annex A5 Numbers of houses of different types and at different distances from Botley West Solar Farm. See notes below Table.

RANGE 0 to 0.1 km				LA1, LA2 etc	LB1, LB2 etc	E1, E2 etc	FW1,FW	FO1, FO2 etc		O1,O2 e	
Area BWSF all	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm with dwelling	Farm without dwelling	Industrial	Other	TOTALS
Sum, n	**104**	**54**	**91**	**3**	**2**	**1**	**3**	**1**	**10**	**1**	**255**
Total Value, Jan 27, ££	60,500,122	21,067,616	32,000,648	1,745,196	1,163,464	581,732					**£117,058,778**
Loss in value %	-6.95775	-6.95775	-6.95775	-6.95775	-6.95775	-6.95775					
Actual loss ££	-4,209,447	-1,465,832	-2,226,525	-121,426	-80,951	-40,475					**-£8,144,657**
Loss per property	-40,475	-27,145	-24,467	-40,475	-40,475	-40,475					
Total Value, Jan 67	122,846,558	43,508,499	65,886,825	3,543,651	2,362,434	1,181,217					**£239,329,183**
Loss in value% of INCREASE in hou	-0.695775	-0.695775	-0.695775	-0.695775	-0.695775	-0.695775					
Actual loss	-433,791	-156,138	-235,772	-12,513	-8,342	-4,171					**-£850,727**
Increase per month/property, '27	1,248.93	865.77	775.78	1,248.93	1,248.93	1,248.93					
Actual loss per month/property	-8.69	-6.02	-5.40	-8.69	-8.69	-8.69					

RANGE 0.1 to 0.2 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industria	Other	
Sum, n	**120**	**118**	**69**	**0**	**2**	**0**	**2**	**1**	**4**	**5**	**309**
Total Value, Jan 27, ££	69,807,833	46,036,643	24,263,503	0	1,163,464	0					**£141,271,442**
Loss in value %	-6.43325	-6.43325	-6.43325	-6.43325	-6.43325	-6.43325					
Actual loss ££	-4,490,912	-2,961,652	-1,560,932	0	-74,849	0					**-£9,088,345**
Loss per property	-37,424	-25,099	-22,622		-37,424						
Total Value, Jan 67	141,746,028	95,074,127	49,963,983	0	2,362,434	0					**£289,146,571**
Loss in value% of INCREASE in hou	-0.643325	-0.643325	-0.643325	-0.643325	-0.643325	-0.643325					
Actual loss	-462,796	-315,470	-165,338	0	-7,713	0					**-£951,318**
Increase per month/property, '27	1,249	866	776		1,249						
Actual loss per month/property	-8.03	-5.57	-4.99		-8.03						

RANGE 0.2 to 0.3 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industria	Other	
Sum, n	**125**	**38**	**141**	**1**	**3**	**0**	**3**	**2**	**3**	**2**	**308**
Total Value, Jan 27, ££	72,954,451	15,180,710	49,582,419	598,729	1,745,196	0					**£140,061,505**
Loss in value %	-5.92875	-5.92875	-5.92875	-5.92875	-5.92875	-5.92875					
Actual loss ££	-4,325,287	-900,026	-2,939,618	-35,497	-103,468	0					**-£8,303,896**
Loss per property	-34,602	-23,685	-20,848	-35,497	-34,489						
Total Value, Jan 67	147,863,010	31,270,811	102,096,461	1,196,281	3,543,651	0					**£285,970,213**
Loss in value% of INCREASE in hou	-0.592875	-0.592875	-0.592875	-0.592875	-0.592875	-0.592875					
Actual loss	-444,114	-95,394	-311,343	-3,543	-10,663	0					**-£865,056**
Increase per month/property, '27	1,248	882	776	1,245	1,249						
Actual loss per month/property	-7.40	-5.23	-4.60	-7.38	-7.40						

RANGE 0.3 to 0.4 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industria	Other	
Sum, n	**112**	**80**	**159**	**3**	**1**	**0**	**0**	**1**	**4**	**2**	**355**
Total Value, Jan 27, ££	65,493,918	31,587,536	55,921,111	1,745,196	598,729	0					**£155,346,491**
Loss in value %	-5.44425	-5.44425	-5.44425	-5.44425	-5.44425	-5.44425					
Actual loss ££	-3,565,653	-1,719,704	-3,044,485	-95,013	-32,596	0					**-£8,457,451**
Loss per property	-31,836	-21,496	-19,148	-31,671	-32,596						
Total Value, Jan 67	132,597,575	65,149,208	115,057,367	3,543,651	1,196,281	0					**£317,544,082**
Loss in value% of INCREASE in hou	-0.544425	-0.544425	-0.544425	-0.544425	-0.544425	-0.544425					
Actual loss	-365,329	-182,718	-321,953	-9,791	-3,253	0					**-£883,044**
Increase per month/property, '27	1,248	874	775	1,249	1,245						
Actual loss per month/property	-6.80	-4.76	-4.22	-6.80	-6.78						

RANGE 0.4 to 0.5 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industria	Other	
Sum, n	**150**	**186**	**120**	**4**	**2**	**0**	**2**	**2**	**2**	**0**	**462**
Total Value, Jan 27, ££	88,075,650	73,172,419	42,200,982	2,394,916	1,197,458	0					**£207,041,425**
Loss in value %	-4.97975	-4.97975	-4.97975	-4.97975	-4.97975	-4.97975					
Actual loss ££	-4,385,947	-3,643,804	-2,101,503	-119,261	-59,630	0					**-£10,310,145**
Loss per property	-29,240	-19,590	-17,513	-29,815	-29,815						
Total Value, Jan 67	177,905,612	150,977,775	86,864,997	4,785,124	2,392,562	0					**£422,926,070**
Loss in value% of INCREASE in hou	-0.497975	-0.497975	-0.497975	-0.497975	-0.497975	-0.497975					
Actual loss	-447,331	-387,451	-222,416	-11,903	-5,951	0					**-£1,075,052**
Increase per month/property, '27	1,248	871	775	1,245	1,245						
Actual loss per month/property	-6.21	-4.34	-3.86	-6.20	-6.20						

RANGE 0.5 to 0.6 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industria	Other	
Sum, n	**112**	**254**	**121**	**7**	**4**	**1**	**2**	**0**	**4**	**0**	**499**
Total Value, Jan 27, ££	65,748,874	100,809,867	42,549,997	4,174,106	2,394,916	581,732					**£216,259,493**
Loss in value %	-4.53525	-4.53525	-4.53525	-4.53525	-4.53525	-4.53525					
Actual loss ££	-2,981,876	-4,571,979	-1,929,749	-189,306	-108,615	-26,383					**-£9,807,909**
Loss per property	-26,624	-18,000	-15,948	-27,044	-27,154	-26,383					
Total Value, Jan 67	132,823,536	207,804,320	87,610,296	8,358,903	4,785,124	1,181,217					**£442,563,396**
Loss in value% of INCREASE in hou	-0.453525	-0.453525	-0.453525	-0.453525	-0.453525	-0.453525					
Actual loss	-304,200	-485,247	-204,360	-18,979	-10,840	-2,719					**-£1,026,345**
Increase per month/property, '27	1,248	878	776	1,245	1,245	1,249					
Actual loss per month/property	-5.66	-3.98	-3.52	-5.65	-5.65	-5.66					

RANGE 0.6 to 0.7 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	115	206	91	6	5	1	0	0	3	0	424
Total Value, Jan 27, ££	67,952,991	81,456,008	32,006,624	3,575,377	2,959,651	598,729					£188,549,380
Loss in value %	-4.11075	-4.11075	-4.11075	-4.11075	-4.11075	-4.11075					
Actual loss ££	-2,793,378	-3,348,453	-1,315,712	-146,975	-121,664	-24,612					-£7,750,794
Loss per property	-24,290	-16,255	-14,458	-24,496	-24,333	-24,612					
Total Value, Jan 67	136,773,918	167,976,477	65,838,683	7,162,622	5,951,277	1,196,281					£384,899,257
Loss in value% of INCREASE in hou	-0.411075	-0.411075	-0.411075	-0.411075	-0.411075	-0.411075					
Actual loss	-282,906	-355,664	-139,075	-14,746	-12,298	-2,456					-£807,145
Increase per month/property, '27	1,247	875	775	1,246	1,247	1,245					
Actual loss per month/property	-5.13	-3.60	-3.18	-5.12	-5.12	-5.12					

RANGE 0.7 to 0.8 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	278	263	203	3	2	1	1	0	8	3	750
Total Value, Jan 27, ££	164,373,021	104,195,718	71,392,056	1,762,193	1,180,461	581,732					£343,485,181
Loss in value %	-3.70625	-3.70625	-3.70625	-3.70625	-3.70625	-3.70625					
Actual loss ££	-6,092,075	-3,861,754	-2,645,968	-65,311	-43,751	-21,560					-£12,730,420
Loss per property	-21,914	-14,683	-13,034	-21,770	-21,875	-21,560					
Total Value, Jan 67	330,728,298	214,825,012	146,930,012	3,558,715	2,377,498	1,181,217					£699,600,751
Loss in value% of INCREASE in hou	-0.370625	-0.370625	-0.370625	-0.370625	-0.370625	-0.370625					
Actual loss	-616,554	-410,020	-279,963	-6,658	-4,437	-2,222					-£1,319,853
Increase per month/property, '27	1,247	876	775	1,248	1,247	1,249					
Actual loss per month/property	-4.62	-3.25	-2.87	-4.62	-4.62	-4.63					

RANGE 0.8 to 0.9 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	421	182	281	4	10	0	0	0	6	3	898
Total Value, Jan 27, ££	248,920,453	71,862,691	98,827,774	2,360,922	5,919,302	0					£427,891,141
Loss in value %	-3.32175	-3.32175	-3.32175	-3.32175	-3.32175	-3.32175					
Actual loss ££	-8,268,515	-2,387,099	-3,282,812	-78,424	-196,624	0					-£14,213,474
Loss per property	-19,640	-13,116	-11,683	-19,606	-19,662						
Total Value, Jan 67	500,847,443	148,216,372	203,351,339	4,754,996	11,902,554	0					£869,072,702
Loss in value% of INCREASE in hou	-0.332175	-0.332175	-0.332175	-0.332175	-0.332175	-0.332175					
Actual loss	-836,838	-253,628	-347,201	-7,953	-19,875	0					-£1,465,495
Increase per month/property, '27	1,247	874	775	1,247	1,247						
Actual loss per month/property	-4.14	-2.90	-2.57	-4.14	-4.14						

RANGE 0.9 to 1.0 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	484	220	182	2	8	1	1	0	11	0	897
Total Value, Jan 27, ££	285,569,565	86,771,662	64,011,336	1,163,464	4,704,847	581,732					£442,802,606
Loss in value %	-2.95725	-2.95725	-2.95725	-2.95725	-2.95725	-2.95725					
Actual loss ££	-8,445,006	-2,566,055	-1,892,975	-34,407	-139,134	-17,203					-£13,094,780
Loss per property	-17,448	-11,664	-10,401	-17,203	-17,392	-17,203					
Total Value, Jan 67	575,264,107	178,987,280	131,692,771	2,362,434	9,494,928	1,181,217					£898,982,736
Loss in value% of INCREASE in hou	-0.295725	-0.295725	-0.295725	-0.295725	-0.295725	-0.295725					
Actual loss	-856,699	-272,705	-200,151	-3,546	-14,165	-1,773					-£1,349,039
Increase per month/property, '27	1,247	873	775	1,249	1,247	1,249					
Actual loss per month/property	-3.69	-2.58	-2.29	-3.69	-3.69	-3.69					

RANGE 1.0 to 1.1 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	533	203	365	1	4	1	2	0	6	0	1,107
Total Value, Jan 27, ££	314,346,383	79,553,981	128,353,282	598,729	2,360,922	598,729					£525,812,027
Loss in value %	-2.61275	-2.61275	-2.61275	-2.61275	-2.61275	-2.61275					
Actual loss ££	-8,213,085	-2,078,547	-3,353,550	-15,643	-61,685	-15,643					-£13,738,154
Loss per property	-15,409	-10,239	-9,188	-15,643	-15,421	-15,643					
Total Value, Jan 67	633,384,761	164,213,446	264,279,119	1,196,281	4,754,996	1,196,281					£1,069,024,883
Loss in value% of INCREASE in hou	-0.261275	-0.261275	-0.261275	-0.261275	-0.261275	-0.261275					
Actual loss	-833,568	-221,194	-355,140	-1,561	-6,255	-1,561					-£1,419,279
Increase per month/property, '27	1,247	869	776	1,245	1,247	1,245					
Actual loss per month/property	-3.26	-2.27	-2.03	-3.25	-3.26	-3.25					

RANGE 1.1 to 1.2 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	416	399	288	1	3	0	0	0	3	0	1,107
Total Value, Jan 27, ££	244,838,996	156,983,161	101,281,161	581,732	1,779,190	0					£505,464,241
Loss in value %	-2.28825	-2.28825	-2.28825	-2.28825	-2.28825	-2.28825					
Actual loss ££	-5,602,528	-3,592,167	-2,317,566	-13,311	-40,712	0					-£11,566,285
Loss per property	-13,468	-9,003	-8,047	-13,311	-13,571						
Total Value, Jan 67	493,901,935	323,902,069	208,485,622	1,181,217	3,573,779	0					£1,031,044,622
Loss in value% of INCREASE in hou	-0.228825	-0.228825	-0.228825	-0.228825	-0.228825	-0.228825					
Actual loss	-569,918	-381,952	-245,311	-1,372	-4,106	0					-£1,202,659
Increase per month/property, '27	1,247	872	775	1,249	1,246						
Actual loss per month/property	-2.85	-1.99	-1.77	-2.86	-2.85						

RANGE 1.2 to 1.3 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	**392**	**330**	**487**	**0**	**4**	**0**	**1**	**0**	**3**	**1**	**1,213**
Total Value, Jan 27, ££	230,146,556	129,917,109	171,260,423	0	2,343,925	0					**£533,668,012**
Loss in value %	-1.98375	-1.98375	-1.98375	-1.98375	-1.98375	-1.98375					
Actual loss ££	-4,565,532	-2,577,231	-3,397,379	0	-46,498	0					**-£10,586,639**
Loss per property	-11,647	-7,810	-6,976		-11,624						
Total Value, Jan 67	464,904,973	268,038,698	352,569,239	0	4,739,932	0					**£1,090,252,842**
Loss in value% of INCREASE in hou	-0.198375	-0.198375	-0.198375	-0.198375	-0.198375	-0.198375					
Actual loss	-465,702	-273,999	-359,671	0	-4,753	0					**-£1,104,125**
Increase per month/property, '27	1,248	872	776		1,248						
Actual loss per month/property	-2	-2	-2		-2						
RANGE 1.3 to 1.4 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	**328**	**263**	**604**	**2**	**7**	**1**	**1**	**0**	**4**	**2**	**1,205**
Total Value, Jan 27, ££	192,354,809	103,234,182	212,408,860	1,163,464	4,106,118	581,732					**£513,849,164**
Loss in value %	-1.69925	-1.69925	-1.69925	-1.69925	-1.69925	-1.69925					
Actual loss ££	-3,268,589	-1,754,207	-3,609,358	-19,770	-69,773	-9,885					**-£8,731,582**
Loss per property	-9,965	-6,670	-5,976	-9,885	-9,968	-9,885					
Total Value, Jan 67	388,809,976	213,056,125	437,242,633	2,362,434	8,298,647	1,181,217					**£1,050,951,031**
Loss in value% of INCREASE in hou	-0.169925	-0.169925	-0.169925	-0.169925	-0.169925	-0.169925					
Actual loss	-333,826	-186,615	-382,049	-2,037	-7,124	-1,019					**-£912,670**
Increase per month/property, '27	1,248	870	776	1,249	1,248	1,249					
Actual loss per month/property	-2.12	-1.48	-1.32	-2.12	-2.12	-2.12					
RANGE 1.4 to 1.5 km											
Range	Single det	Semi-det 2	Multi-det	Large det1	Large det2	Estate	Farm wi	Farm wi	Industri	Other	
Sum, n	**301**	**314**	**437**	**0**	**3**	**0**	**0**	**0**	**5**	**0**	**1,055**
Total Value, Jan 27, ££	177,072,973	122,985,055	153,685,584	0	1,745,196	0					**£455,488,807**
Loss in value %	-1.43475	-1.43475	-1.43475	-1.43475	-1.43475	-1.43475					
Actual loss ££	-2,540,554	-1,764,528	-2,205,004	0	-25,039	0					**-£6,535,126**
Loss per property	-8,440	-5,620	-5,046		-8,346						
Total Value, Jan 67	357,293,723	253,878,307	316,303,758	0	3,543,651	0					**£931,019,438**
Loss in value% of INCREASE in hou	-0.143475	-0.143475	-0.143475	-0.143475	-0.143475	-0.143475					
Actual loss	-258,572	-187,799	-233,316	0	-2,580	0					**-£682,268**
Increase per month/property, '27	1,247	868	775		1,249						
Actual loss per month/property	-1.79	-1.25	-1.11		-1.79						

Sum n (total houses) to 1.5km	**3,991**	**3,110**	**3,639**	**37**	**60**	**7**	**18**	**7**	**76**	**19**	**10,844**
Total Value all buffers, Jan 27, ££	**2,348,156,595**	**1,224,814,359**	**1,279,745,761**	**21,864,023**	**35,362,837**	**4,106,118**	**0**	**0**	**0**	**0**	**£4,914,049,693**
Total loss all buffers, Jan 27, ££	**-73,748,385**	**-39,193,038**	**-37,823,136**	**-934,345**	**-1,204,990**	**-155,763**					**-£153,059,657**
Total Value all buffers, Jan 67, ££	**4,737,691,452**	**2,526,878,522**	**2,634,173,104**	**44,006,307**	**71,279,745**	**8,298,647**	**0**	**0**	**0**	**0**	**£10,022,327,777**
Total loss all buffers, Jan 67, ££	**-7,512,145**	**-4,165,994**	**-4,003,057**	**-94,602**	**-122,357**	**-15,921**					**-£15,914,075**
											-£1,468
								Estimated total loss to Jar			**-£168,973,732**

Key to Table.

Dwellings were classified as Detached, Semi-detached, Terraced ('Multi-det'), Large detached without tennis court/swimming pool ('Large det1'), Large detached with these feature ('Large det 2'), Estates, Farms with and Farms without residences, Industrial and Other.

The numbers of each house type ('Sum, n', figures in red) were counted for each 0.1km buffer (the 'RANGE' values in the main body of the table) around the proposed Botley West Solar Farm and their total value calculated at Jan 2027 (the proposed commissioning date of BWSF). Farms, Industrial and Other sites were not included in these totals. The 'Loss in value %' figures were derived from Figure 1 (the fitted Droes & Koster 2021 curve) and applied to this total to give the 'Actual loss ££' figures (i.e. all houses), and the 'Loss per property' figures. These are therefore the expected immediate losses in value that arise in January 2027 from the newly installed solar farm.

The predicted 'Total Value, Jan 67' is derived from extrapolating the ONS house value data for each house type, shown here in Annex A3, and applying these figures to the total numbers of houses of each type.

The 'Loss in value % of INCREASE in house value' is derived from the same Droes & Koster loss curve but at a lower fractional value (here 0.1). The resulting percentage loss is applied to the expected increase in house values between 2027 and 2067 (i.e. in the absence of the solar farm) to give the 'Actual loss' figures. The 'Increase per month/property' is the predicted increase in property values between the 2027 and 2067 divided by the number of months in between and the 'Actual loss per month/property' is the predicted loss per property (2027 to 2067) due to BWSF. These additional losses should be added to the immediate losses at January 2027 to calculate the total expected losses in property values to 2067. The right-most column shows totals across the values in the body of the table.

The summary table (immediately above here) gives the totals across all buffer zones out to 1.5kms. The total January 2027 value of all 10,844 properties is £4,914,049,693 and the calculated immediate loss in value caused by BWSF is £153,059,657. The expected value of all properties in January 2067 in the absence of BWSF is £10,022,327,777, and the additional loss 2027 to 2067 due to BWSF is estimated to be £15,914,075 (applying a factor of 0.1 to the loss curve applied to the expected January 2027 values). Thus, under these assumptions, the total loss to 2067 in the value of all houses around BWSF is £169,973,732. (The figure of -£1,468 in the summary is the total additional loss 2027 to 2067 divided by the total number of properties and is therefore the average additional loss per property, 2027 to 2067, for all property types at all distances from BWSF.)

Annex B

The effects of utility-scale solar PV installations on house values.

This Annex investigates the literature on the effects of utility scale solar PV installations on house values. It does not consider either utility scale Concentrated Solar Power (CSP) installations or rooftop solar PV installations on individual houses.

CohnReznick LLC. Nation-wide, USA

Numerous studies claim there is no effect of utility solar farms on house prices. Most have been carried out by real-estate agents (realtors) in the USA for solar energy and other developers and have not been peer-reviewed.

CohnReznick LLP produced a series of reports from 2018 to 2021, covering 22 American counties in 10 different states[3,4,5,6,7,8,9,10,11,12]. The November 2021 Report is a useful place to start because it reviews many of the previous studies. The March 2021 Report contains a summary table referred to later.

The 'matched pair' approach adopted by CohnReznick is more or less the same in each of their reports. Property sales close to existing solar farms (the so-called 'Adjoining Properties', giving the 'Test' sale results) are compared with sales of similar properties at some distance from the solar farms, and usually out of sight of it ('Control' properties).

All adjoining property sales are first examined to make sure they were 'market' or 'arms' length' sales (i.e. not to a relative, friend or neighbour, that could affect the sale price). Certain sales were also eliminated when equivalent control sales could not be found (because of the unusual structure or some other feature of the 'Test' property). CohnReznick also tried to ensure similar sized plots of Test and Control sale houses (plot sizes are extremely variable in the USA; some local authorities allow a maximum density of only one house per acre!). The result of this filtering process usually resulted in only one Test house sale being compared with a collection of Control house sales at each solar farm site.

Since Control house sales often pre-dated Test house sales adjustments had to be made for the changing property values between sale dates. This was done using area-wide Federal Housing Finance Agency (FHFA) House Price Index (HPI) figures 'for macro and micro regions' in the United States. Prices were adjusted to the same sale date using the FHFA figures.

The results are presented as the percentage difference in sale price per square foot of the property (i.e. the house, not the plot). These differences are usually small (range -0.61% to +8.91%; values of +2.0% to +3.0% are commonest) and usually indicate a slight <u>increase</u> in the value of houses close to the solar farms (i.e. a positive percentage difference in values).

CohnReznick conclude "*the data indicates* (sic) *that solar facilities do not have a negative impact on adjacent property values.*"

There are several comments and criticisms that can be made of these studies:

1) The solar farms are all relatively small compared with Botley West, from a very few MW (most of them) to 120MW.
2) Adjustment using the FHFA index will vary depending on the size of the FHFA unit considered (usually not specified). For example, for the North Star Solar Farm, Chisago County, Minnesota, adjustments were made using figures for the local zipcode (55056), an area of at least 100 sq. kms. Adjusting one set of house values (usually the Control houses) to a common sale date (usually that of the Test house) could introduce a bias in the results if

the FHFA index does not reflect prices in the precise areas from which the control houses came.

3) CohnReznick do not make adjustments for different 'features' of otherwise identical houses (Test and Control). No two houses are identical. Other studies do make such adjustments (although valuing them is subjective).
4) There is a potentially serious methodological flaw in most comparisons that CohnReznick carry out. The results are usually presented as 'median values' (i.e. of price per sq. foot). Since Test sales are usually only of a single property, the value given has to be that of the property, which is a sample of the mean of the distribution of local house prices. But there is usually a collection of Control houses, for which the median value is reported (the median is the value that divides a distribution into exactly equal halves, with as many observations above the median as below it).
Means and medians will be comparable only if the overall distribution of house prices is statistically 'normal' (i.e. with equal-sized 'tails') – Figure B1. If the overall distribution is skewed they will differ – Figure B2.

Figure B1. A normal distribution. This distribution has equal-sized 'tails' and the median, mode and mean are all the same.

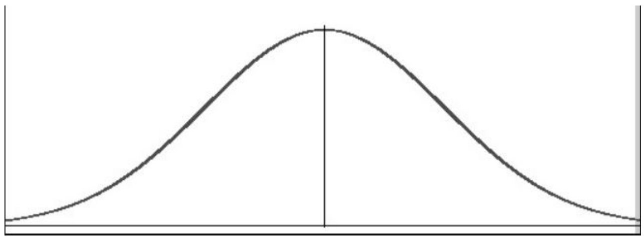
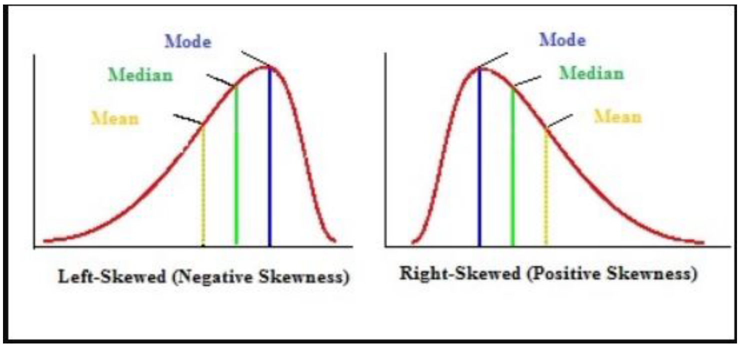


Figure B2. Two examples of skewed distributions. House prices tend to have a right-skewed distribution – with more very expensive houses far from the modal value. The mode, mean and median values differ.



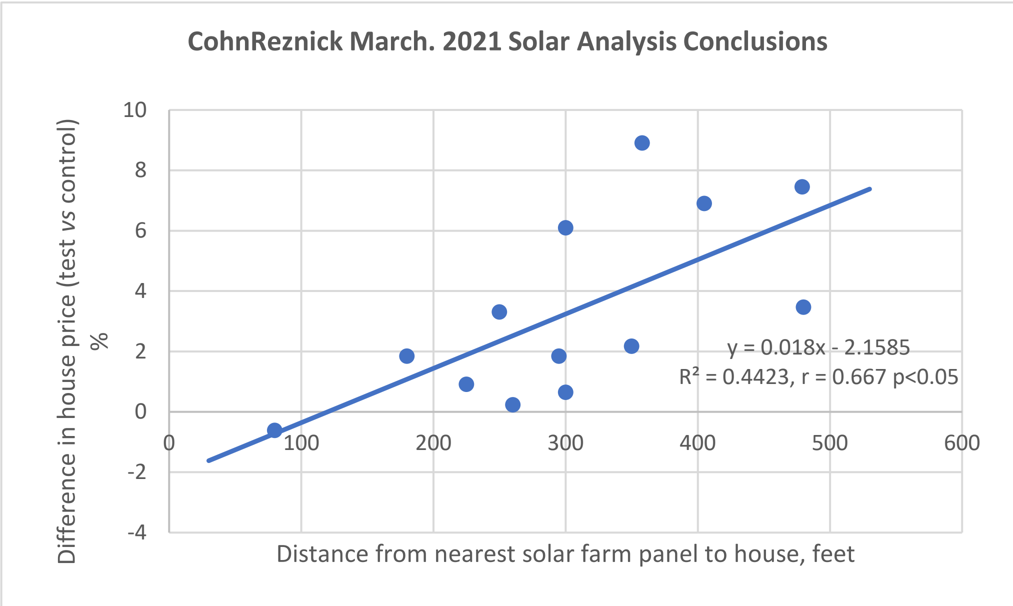
House prices tend to be right-skewed (Figure B2, right), in which case the mean is always larger than the median. It follows that a sample (however small) of the mean of a right-skewed distribution will on average have a higher value than a sample of the median. This could explain the frequent finding of CohnReznick that Test house values (reported as the 'median' but, when a sample of one, is really an 'estimate' of the mean) are often just a few percentage points higher than the median of a group of Control house values, suggesting that houses near to solar farms are worth just a bit more than houses far away from them.

The extent of the difference between median and mean values obviously depends on the skewness of house price distribution in the local area.

This finding rather undermines many of CohnReznick's conclusions, although how much it does so would require much more information on local house prices than the reports present.

5) Finally, CohnReznick usually choose test houses on plots immediately adjacent to Solar Farms, although the distance of the houses to the nearest solar panel will vary from site to site, something they claim also has no effect on house prices. However, data in their March 2021 Executive Summary document show otherwise. The Table on p. 4 of that document summarises data from studies of solar farms in nine different counties in seven different states, a total of 26 Test sales (nine single sales) and 94 Control sales. Data are given for the average distance from the local solar farm (the nearest panel) to the Test house, and for the percentage difference between test and control house values. The results are plotted here in Figure B3.

Figure B3. Relationship between the difference in value of houses next to solar farms (the test houses) and comparable houses at some distance away from – and out of sight of - the solar farms (the control houses). A positive difference indicates that test houses are more valuable than control houses (data from CohnReznick9).



There is a significant ($p<0.05$) relationship between the difference in house prices and the distance from the solar farm to the test houses. In comparison with control houses, test houses nearer to solar farms are worth less than test houses farther away from their nearest solar farm.

Both the methodological problem of the skewed distribution and the demonstration of a 'distance effect' on house prices cast doubt on many of the CohnReznick studies and conclusions. Proper peer review of their Reports should have revealed these problems.

Unfortunately, the CohnReznick results are often reported by other agencies promoting solar farms.

Kirkland Appraisals LLC. North Carolina and Tennessee, USA

This company was asked by a solar farm developer to estimate the impact of a solar farm proposed near Grandy, North Carolina. It did so by looking at sales of both houses and plots near four solar farms elsewhere[13]. Two of the four concerned land sales only and are not considered further here. A matched group study of five test houses (called 'adjoining' by Kirkland) and eight control houses (called 'nearby' by Kirkland) at Golsboro, North Carolina, found that the median (and mean) house price of the control houses was 2% lower than that of the test houses. However, both the mean plot and house sizes of the control houses were smaller than those of the test houses, so they weren't exactly comparable.

The other matched group study at Selmer, Tennessee, compared data for four test houses bought after solar farm installation and included data for sales of five control houses, three sold before the solar farm was announced and two afterwards. For this study Kirkland adjusted the value of each house (both test and control) on the basis of its unique characteristics compared with those of one of the houses (a test house) within the entire group. The adjustments ranged in value from c. +$1,500 to c. +$50,000 but, for some reason, were totally ignored in the matched pair summary of results.

For other unexplained reasons there was also a huge difference between the two sets of control houses; the mean value of the three sold before the farm was announced was $180,667 (sale dates April 2012 to February 2013) and of the two sold after (sale dates February and March 2015) was $134,450.

The matched pair summary of results compared the unadjusted mean and median house prices of the four test houses and the two control houses sold after the farm was announced, finding the latter was about 3% more than the former, a difference Kirkland accounted for by the difference in house sizes (prices per sq. ft floor area were much more similar), building age and lot sizes.

The overall conclusion from Kirkland's study is that, at least in terms of house prices, it really shows nothing much one way or the other. It cannot be used to claim 'no effect' of solar farms on house prices, but it does highlight the problem with matched pair studies involving small numbers of houses, including adjustments for differences in property features and sale dates.

Al-Hamoodah et al (2018), University of Texas. Nation-wide, USA

Al-Hamoodah et al reviewed a large dataset of solar installations for the housing and income characteristics of the surrounding areas[14]. A survey questionnaire was also produced to see if, in the view of experienced property assessors, solar installations affect nearby residential property values. The authors claim to have produced the first peer-reviewed study of the quantitative impacts of utility scale solar on property values.

Using information from 956 of the US Energy Information Administration's database of 1,805 installations (checking that their sample was representative of the whole), with a sample mean of $12MW_{AC}$ installed capacity (minimum = $0.4MW_{AC}$, maximum = $314MW_{AC}$, median = $4MW_{AC}$), Al-Hamoodah et al looked first at the number of houses within buffer zones of 100, 500, 1,000 feet, one mile and three miles from pseudo-polygons created in a GIS around the assumed geo-centre of each solar installation site, assuming an area of 6 acres per installed MW. There were many fewer houses around each of the 27 largest solar farms in the database with a recorded capacity of 100MW or larger, compared with each of the 521 smallest solar farms of up to 5MW capacity.

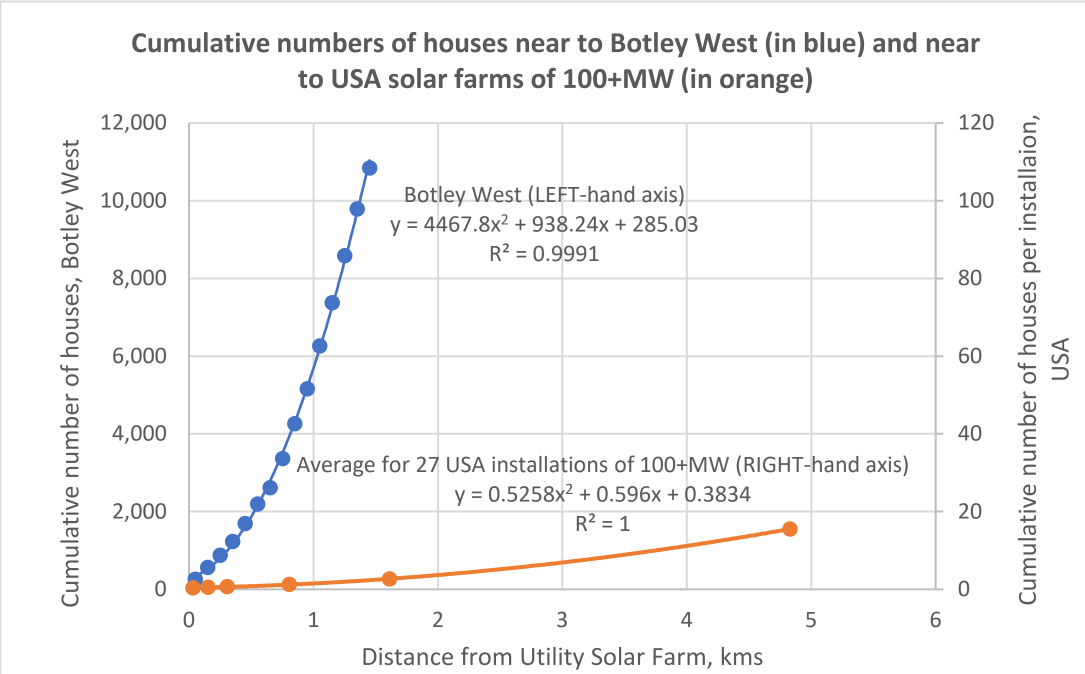
Al-Hammodah et al present the results as the cumulative numbers of houses at each distance (thus the 3-mile number includes all houses within the 3 mile buffer, not just those in the 1.5 to 3 mile buffer). The results for the largest solar farms in Al-Hamoodah et al's study are shown in Figure B4 which includes for comparison the results for Botley West (this study).

There are <u>orders of magnitude differences</u> between the USA situation and what is proposed for Oxfordshire. In the American study there are, on average, only 2.46 houses within 1.5kms of installations of 100MW to 314MW capacity. Botley West, on the other hand, will have 10,844 properties within the same distance of an installation up to ten times larger – a >4,400 fold difference in house numbers!

Even for the smallest American installations of up to 5MW (n=521), the predicted number of houses to 1.5 kms would be 1,432, still only a fraction of the Botley West figure.

Al-Hamoodah et al found that the median incomes of residents is smallest near the 100MW facilities and increases the smaller is the size of the solar installation, approaching the national mean income at the smallest solar installation sizes (up to 5MW). This probably happens because the largest solar farms are sited in rural areas, where incomes are lower but where house prices also tend to be lower.

Figure B4. The total number of houses within certain distances of 100+MW solar farm installations in the USA (orange dots and line, the average of 27 installations; right-hand scale) and of the proposed Botley West Solar Farm (blue dots and line; left-hand scale). Botley West will have more than **4,400 times** more houses within 1.5kms distance than do the largest USA installations in Al-Hamoodah et al's study.



Al-Hamoodah et al sent a survey questionnaire to public sector property assessors in 430 USA counties having solar installations. The assessors were asked to estimate the impacts on property values at different distances from three different solar installations (1.5MW, 20MW and 102MW capacities). The responses involved moving 'sliders' on a -50% to +50% scale, in 10% increments. Assessors were supplied with satellite images of actual farms of those three sizes, showing surrounding areas.

There was a 10% response to the questionnaire from 23 of the 42 states known to have solar installations.

Although both the median and mode of the responses were zero there were, nevertheless, significant average negative estimated impacts for all three solar installation sizes, with larger differences closer to the solar installation. These significant differences extended out to 1000 feet from the 1.5MW and 20MW installations and to half a mile from the 102MW installation.

One of the questions posed was whether or not the assessor had assessed a home near to a utility scale installation; 45% had and the remainder had not. Al-Hamoodah et al found that the estimated impact depended on this prior experience. Those with no prior experience estimated a significantly greater negative impact of solar farms on house values than those with prior experience.

For present purposes we show the results only for the experienced assessors in Figure B5. These results are also included in Figure 1 in the main text.

Figure B5. Effect of a 102MW solar farm on house values as estimated by experienced assessors in 23 USA states (data from Al-Hamoodah et al 2018)

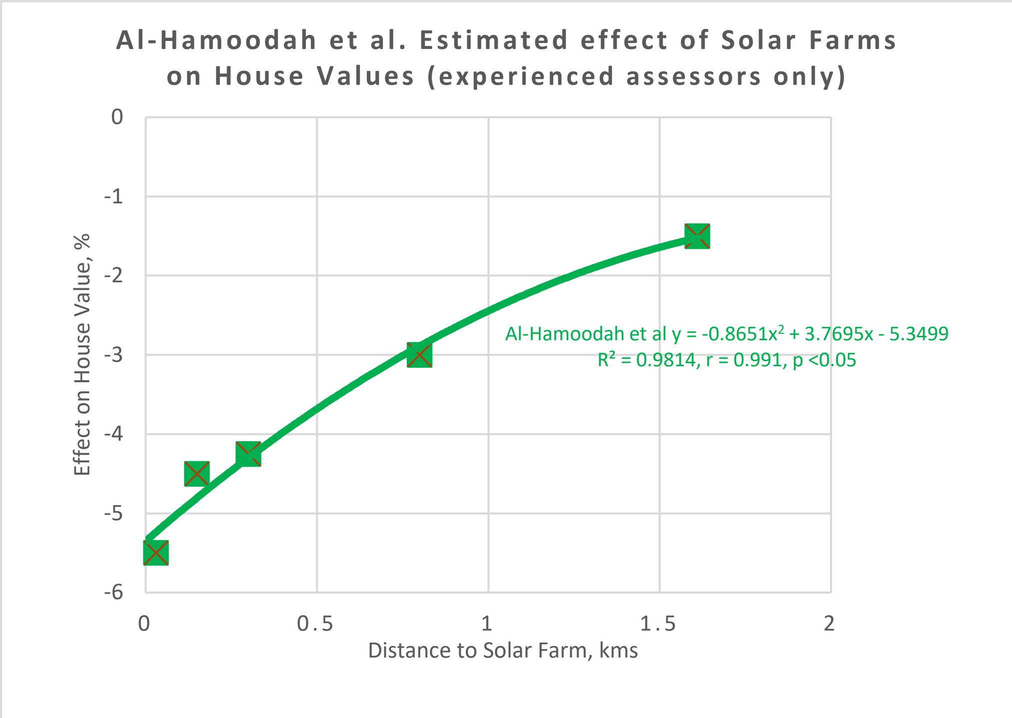


Figure B5 shows that the estimated negative impacts were stronger nearer to the solar farm.

It is important to stress two things in these results. First these are estimates of impacts based on experienced assessors' judgements, not on house sale data. Second, many respondents of both sorts estimated there is no impact at all (hence the overall zero median and mode). Nevertheless, those judging a negative effect set this at such a value to give the significant differences in the mean values mentioned above.

Gaur & Lang (2020), University of Rhode Island. Massachusetts and Rhode Island, USA

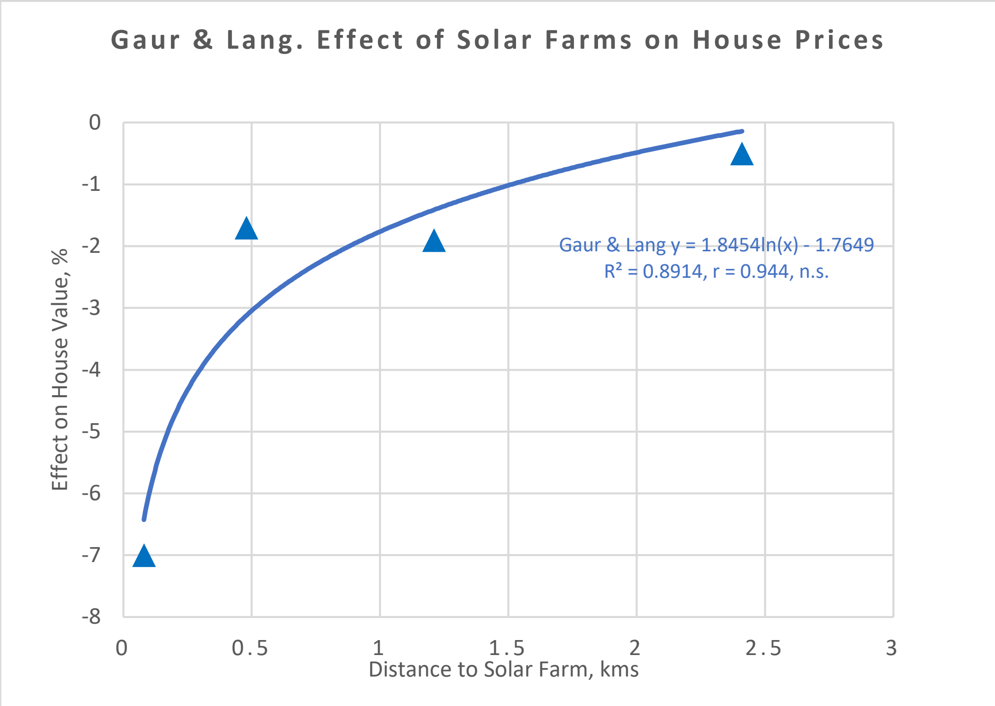
The first very large-area analysis of actual house sales was carried out by Gaur & Lang (2020) using data from 71,337 housing transactions up to one mile (treated or test group) and 347,921 transactions between one and three miles (control group) from 208 solar installations in Massachusetts and Rhode Island[15]. They used a 'difference-in-difference' (DID) hedonic price method comparing house prices after solar farm construction of nearby properties compared with those farther away (the hedonic method assumes that price is determined both by internal characteristics of the good being sold and external factors affecting it). Overall they found a decrease of 1.7% in the value of houses within one mile of a solar farm, but this effect varied with distance. Houses within 0.1mile of any solar farm had sale prices 7% lower and those 0.1 to 1 mile away had sale prices 1.7% to 1.9% lower than control group houses. The effect disappeared between 1 and 2 miles. These results are shown in Figure B6.

Gaur and Lang also investigated the context of these differences and whether or not they depended on the characteristics of the surrounding areas. They found no difference between nearby and distant prices in what they call 'rural' areas, with fewer than 850 people per square mile (the average population density of Massachusetts). The negative externalities of solar farms in this study were found only in non-rural areas (>850 people per sq. mile).

They defined a further variable 'greenfield' for whether or not the solar farm had been built on previously farmed or forested areas and found that this variable added to that of the non-rural characteristic such that houses within one mile of a solar farm built on greenfield (as opposed to brownfield/industrial) sites in non-rural areas had sale values 5.0% lower than control houses.

They interpret these results as suggesting that rural areas have significant open spaces such that the presence of a solar farm makes little difference to the overall rural nature of the area or else that the solar installation is hidden from view by vegetation and so is not noticed. In non-rural areas, however, green spaces are valued because of their scarcity, and loss of green spaces near to houses significantly reduces their value.

Figure B6. Effect of the presence of a solar farm on local house values in Massachusetts and Rhode Island. Data from Gaur & Lang (2020)



It is rather difficult to translate Gaur & Lang's study to the Oxfordshire situation. Rhode Island and Massachusetts are the second and third most densely populated states in the USA. Oxfordshire's 1,006 square miles is home to 707,424 people (2022 figure), giving an average density of 703 people per square mile. It follows that much of the county would be considered non-rural using Gaur & Lang's criteria (of >850 people per sq. mile), and therefore that the loss of green spaces to solar farms would be particularly damaging to house prices. Applying the 5.0% impact found by Gaur & Lang on houses within 1 mile of solar farms built on greenfield land in non-rural areas would create an immediate total loss in house values of £245.7 million in the Botley West setting.

Gaur & Lang go on to calculate that the externalities of the impact of all 284 solar installations on house values in their study ($1.66 billion in aggregate) would be considerably greater than the externality of the solar installations in terms of the value of CO_2 emissions averted by these installations in comparison with the CO_2 emissions of the gas generators otherwise used to provide power in the state (i.e. $771 million of emissions to produce the same amount of electricity, assuming a social cost of $51.80 per metric ton of CO_2, an Environmental Protection Agency figure). In other words, in the Massachusetts' situation, the public loss in property values is much greater than the public benefit in CO_2 emissions averted by the solar installations.

The aggregate loss in property values is so large because there are 289,254 properties situated within one mile of all 284 solar installations. The total installed capacity of the solar farms in Gaur and Lang's study is only 817MW (i.e. lower than Botley West's 1,100MW capacity), or on average, only 2.88MW per installation. A 1 mile radius circle around each installation would cover a total area of 892.3 sq. miles for all 284 installations, giving an average property density of 324 per sq. mile, compared with Botley West's 3,973 properties per sq. mile (Botley West's total area, including the solar farm footprint and out to the 1.5 km buffer, is only 33.62 sq. miles). Thus, there is a much greater property value externality in this American study because of the small size of each of the numerous solar PV installations.

Gaur & Lang warn that theirs are 'back-of-envelope' calculations, and that the results for CO_2 emissions would differ in states that still produce much of their electricity from coal (which emits more CO_2 per MW generated power) rather than gas. And, we might add, states that have larger solar installations and higher house densities.

This is probably the first study that unequivocally shows a negative impact of solar farms on house values and that this impact varies with distance from the solar farm up to about one mile. The results are based on thousands of house sales, 18,000 within half a mile and 71,337 within one mile of solar installations, 27.4% of which occurred post installation.

Since the average size of the solar installations here is rather small, we imagine that the impact of larger farms is even greater. They will be a more obvious feature of the landscape and it is this loss of greenfield sites in populous areas that is mainly responsible for the effects shown in this study.

Gaur's subsequently produced thesis[16] includes a section showing that although people are broadly in favour of solar energy, they are against it when utility-scale solar installations are fully visible, more so when the installations are on previous farmland or forest (measured by the compensation they would require for such developments to happen), but are willing to pay for it if sited on previously commercial or brownfield sites. It seems therefore that the settings of solar installations play a large part in the willingness or otherwise of local people to support such developments.

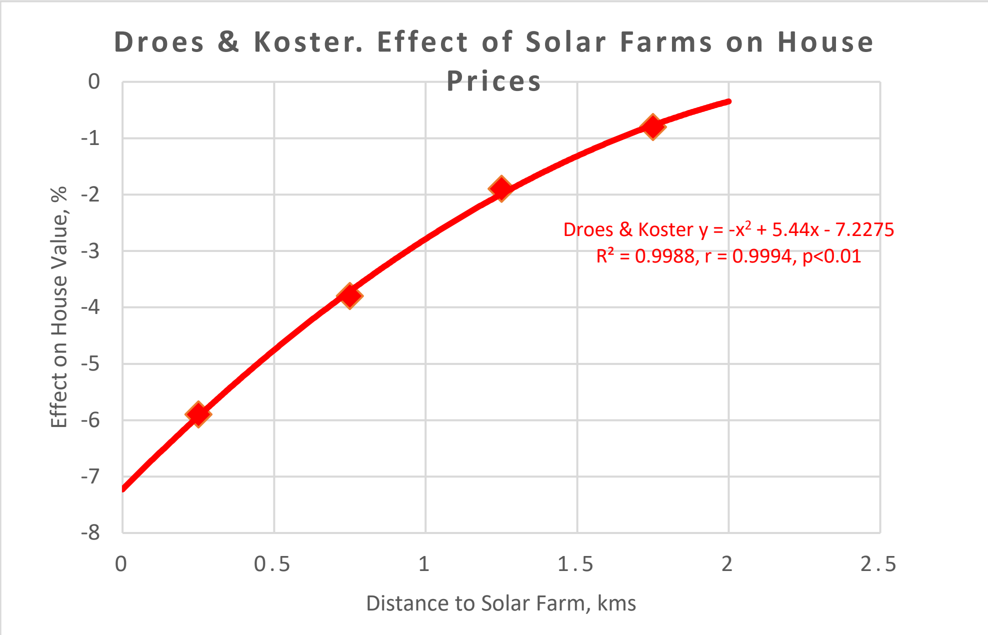
Droes & Koster (2021). Nation-wide, The Netherlands

This appears to be the first quantitative study in a European setting[17]. Using a difference-in-differences hedonic approach, Droes & Koster looked at house prices around 107 solar farms dotted about the Netherlands, ranging in size from 1 to only 109MW and opened mostly between 2017 and 2019. The study had data on 1.5 million house sales, 12,650 of them within 1 km of the solar farms present in 2019. Control group houses were chosen between 2 and 5kms away from the solar farms.

The value of houses sold within 1km of all solar farms was 4.6% less than that of control group houses between 2 and 5kms of solar farms (significant at the 1% level); the difference fell to -2.6% when the control group of houses was between 1 and 2kms away.

When 'decomposed' into 500m bands, the effect within 500m was -5.9% and between 0.5 and 1 km was – 3.8% (both figures significantly different from zero). There was also a difference of -1.9% at a distance of 1.5 km and -0.8% at 2kms but, although following the same trend line, these two points were not significantly different from zero. The results are plotted here as Figure B7, where distances are set at the mid-point values in Droes and Koster's study (their Figure 7); thus the 0.5 km figure is plotted at x = 0.25 kms because the results are for all properties up to 0.5 kms. The best fit regression to these results is a curved line (a polynomial), the fitted line in Figure B7 ($r=0.9994$, $p<0.01$).

Figure B7. Effect of the presence of a solar farm on local house values in The Netherlands. Data from Droes & Koster (2021).



The authors estimate a loss across all solar farms in The Netherlands (i.e. of the values of all houses within 1km of any solar farm) of €800 million, or €7,477,965 per solar farm. This loss per farm is considerably smaller than that estimated for Botley West, because the density of houses around Dutch solar farms is very much lower (median of 178 properties within 1km of any Dutch solar farm). Once again, Botley West stands out as having a very large number of properties close to it, in this case 29 times more properties within 1km than the Dutch median figure above.

The Dutch government compensates home-owners when losses due to infrastructure developments exceed 4% of property values. This is of rather limited use in the Dutch situation because so few properties are close enough to solar farms to experience a loss of 4%. A similar law in the UK, however, would involve compensating c. 2,000 property owners around the BWSF site to the tune of c. £39 million.

Mary McClinton Clay, Kentucky. Nation-wide, USA

Mary McClinton Clay is a professional assessor based in Kentucky who was asked to advise Hardin County (Kentucky) Citizens for Responsible Solar about the possibility of a diminution in property values near to utility scale solar farms[18]. She concludes her analysis of the current literature with:

"These articles, case studies and agreements contradict the unanimous conclusion of solar developer's appraisers that utility scale solar farms are not detrimental conditions, nor do they adversely impact adjacent property values.

*Though diminution in values varies, as the result of a detrimental condition's impact upon a property's utility, the evidence presented by these case studies of 100MW or less solar farms, indicates that solar farms damage property values by **at least -6.0 percent to -30 percent**."* (original author's emphasis).

The literature survey in this document includes both the University of Texas (Al-Hamoodah et al, 2018) and the University of Rhode Island (Gaur and Lang, 2020) studies mentioned here. In addition, reports of three professional appraisers for solar installations in North Carolina, Pennsylvania, Indiana are discussed and show negative impacts when solar farms impair views of previously open land (e.g. farmland) but not when such installations are on previously industrial sites.

McClinton Clay also gives details of several 'good neighbor agreements' whereby solar farm developers make payments to adjacent property owners, often with the condition that the property owners co-operate with the developers. In most cases, the agreements are supposed to be confidential. Sums of $17,000 (Wisconsin), $5,000 to $50,000 (Ohio), 10% of the appraised home's value for properties up to 300 feet away, plus an annual payment of $1,000 for the 35-year project life (Indiana), $1,000 plus tiered payments of between $7,500 and $25,000 (also Ohio) and unspecified (i.e. confidential) (Minnesota) are mentioned. As McClinton Clay comments on these examples:

"these offers … can only reasonably be interpreted as a tacit admission of potential value impairment."

The report contains a re-analysis of the North Star, Minnesota, installation study of KohnReznick12. These authors specifically excluded some adjacent properties from their study because they were bought by the solar farm developers before installation, probably at prices above market value (in order to expedite construction of the installation). Thus, the subsequent, post-installation sale by the developers of these properties on the open market usually involved a loss, giving a false impression of the impact of solar farms on adjacent property values.

McClinton Clay, however, looked at the original sales of the same properties before ever the solar installation was considered. The prices paid were therefore the current market values at the time. By comparing the original sale price (adjusted for average changes in all property values over time) with the open market price paid post-installation (i.e. missing out the sale to the developers) a better estimate of the impact of the solar farm can be gained. These sale-resale studies are obviously ideal, since exactly the same property is being bought and sold before and after solar installation, but they are few in number.

McClinton Clay's sale-resale analysis reveals average change in value of -12.5% in the North Star case (range 0% to -28.0%; median -15.9%). These houses are in the same situation relative to the solar farm as those for which KohnReznick concluded a change of +0.92% and +8.91% in property values (two of the points in Figure B1).

McClinton Clay also carried out a sale-resale analysis of four properties up go 0.27 kms away from McBride Place solar farm, Midland, North Carolina and found an average change in value of -16.1% following the solar installation.

McClinton Clay's results for North Star and McBride place are included as single points in the main text, Figure 1, to emphasise that individual losses revealed by sale-resale analyses may be much greater than the difference-in-differences approach reveals for much larger collections of properties.

Maddison et al (2023). England & Wales

This appears to be the only quantitative analysis to date for any part of the U.K.[19] The authors extracted from the Renewable Energy Planning Database (REPD) information on 1860 planning applications for solar installations ≥ 1MW made up until September 2017, 1060 of which have resulted in operational solar farms with a combined capacity of 8.1GW (thus an average of 7.6MW per installation); the first solar installation became operational in July 2011 and the last in August 2017. In addition, 18 solar farms were under construction and permission granted for 231 more. This dataset allowed the authors to investigate any changes in property values associated with different stages of solar farm construction, from the initial planning application through to becoming operational.

All English and Welsh property transactions with 6-digit postcodes within 1,000 metres of the centre (centroid) of any of the solar installations were extracted from the England and Wales Land Registry (EWLR) database (including transactions where solar farms eventually would be applied for and/or built). The sale data covered the period January 1995 to November 2017. No transactions for any houses outside the 1,000-metre limit were included in the study.

A first series of models looked at the impact of different stages of the planning process on changes in property values (with or without adjustments for time trends) but found no effects at distances of ≤500m, ≤750m and ≤1,000m (with the exception of a separate category of new properties which always had a significant price premium compared with other, older properties in the dataset).

A second series of models dividing the data into geographically distinct regional sets also found no significant effects for properties at distances of ≤750m (a limit selected on the basis of Al-Hamoodah et al's results).

The next series of models looked at site characteristics and found a highly significant -5.6% difference decrease in house values ≤750m South of operational solar installations of >5MW, a result attributed to the obvious glare of South-facing installations (the results were not significant for properties South of installations of ≤5MW). Although there was also a -3.8% decrease in house values ≤750m North of operational solar installations of >5MW this result was not significant.

Further modelling showed even stronger effects of -6.5% for house values ≤500m South of installations of >5MW and of -10.2% for house values ≤750m South of installations >10MW.

There therefore seems to be both distance and orientation effects on house values and these become stronger the larger is the solar installation. Unfortunately, no distances of <500m were included in any of the models, nor solar installations of >>10MW capacity. The other results presented here suggest that both of these factors would have increased the effects noted. Whilst the North/South difference is notable in this dataset (with only the South effect significant), it is possible that the North effect would also become significant (but with a lower impact on house values) for solar installations of the size of BWSF.

Maddison et al's result for houses South of >10MW installations is included as a single point in main text Figure 1 (and applying the Kennedy correction for coefficients in a semi-log equations[20]).

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