

Shadow Flicker Impact Assessment

RSK Environment Limited

Hollandmey Renewable Energy Development

October 2021

PLANNING SOLUTIONS FOR:

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ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	December 2020	Initial issue (10008D)
2	August 2021	Assessment of updated T8 location (10008H)
3	October 2021	Minor amendments

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been commissioned to assess the shadow flicker effects associated with a proposed wind development located in northern Scotland, UK. This report has modelled the shadow flicker effects at relevant identified dwellings in the area surrounding the turbines.

Assessment Methodology

Dwelling receptors have been identified¹ in the area surrounding the proposed wind development up to 10-rotor diameters (1,320m) from the nearest wind turbine. An additional 50m buffer zone has been applied to allow for individual micro-siting of the wind turbines.

Results Overview

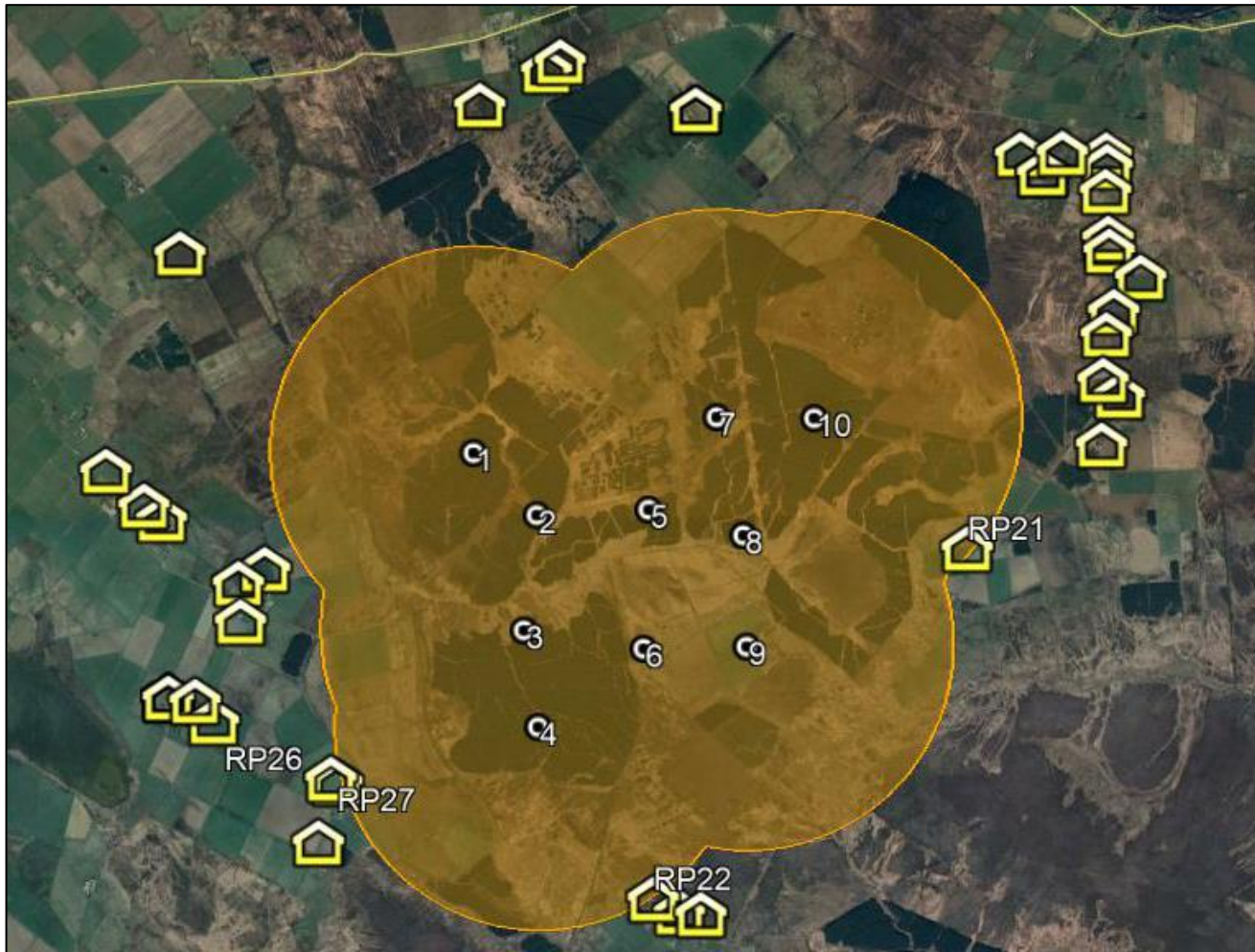
The overall conclusions are presented below:

- 41 surrounding dwellings have been considered within this assessment;
- All dwellings are outside of the 10 rotor diameter zone (1,320m radius from the turbines)
- All dwellings are outside the additional 50m buffer zone applied (on top of the 10 rotor diameter zone), which allows for micro-siting of the turbines;
- No dwellings have therefore required detailed shadow flicker modelling because all dwellings are outside of the associated zones where detailed analysis is required.

Shadow Flicker Analysis Conclusions

In accordance with the industry standard shadow flicker methodology, there will be no significant shadow flicker effects at any of the identified dwellings, either in isolation or cumulatively, requiring mitigation.

¹ Provided by the developer.



Key:

- The turbine positions (circular icons);
- The assessment zone considered relative to the turbines (orange area).
- Identified dwellings (yellow dwelling icons);
- Dwellings 21, 22, 26 and 27 appear close to the 10x rotor diameter zone (1,320m) but remain outside the 50m buffer zone applied to allow for micro-siting of the wind turbines.

Shadow flicker results summary

Shadow Flicker Impact Assessment

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ABOUT PAGER POWER

Pager Power

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 50 countries within Europe, Africa, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

1 BACKGROUND

1.1 Introduction

Pager Power has been commissioned to assess the shadow flicker effects associated with a proposed wind development located in northern Scotland, UK. This report has modelled the shadow flicker effects at relevant identified dwellings in the area surrounding the turbines.

The proposed wind development comprises 10 wind turbines with a maximum tip height of 149.9 metres above ground level (agl) and a rotor diameter of 132 metres.

2 PROPOSED WIND DEVELOPMENT DETAILS

2.1 Wind Turbine Details

The turbine co-ordinates and dimensions are shown in Table 1 below.

ID	Easting	Northing	Rotor Diameter (m)	Tip Height (m agl)
T1	328397	970004	132	149.9
T2	328796	969598		
T3	328700	968860		
T4	328781	968240		
T5	329515	969620		
T6	329467	968729		
T7	329963	970204		
T8	330120	969444		
T9	330129	968731		
T10	330588	970185		

Table 1 Wind turbine details

2.2 Proposed Development Location

The location and application boundary of the proposed development is shown in Figure 1² below.

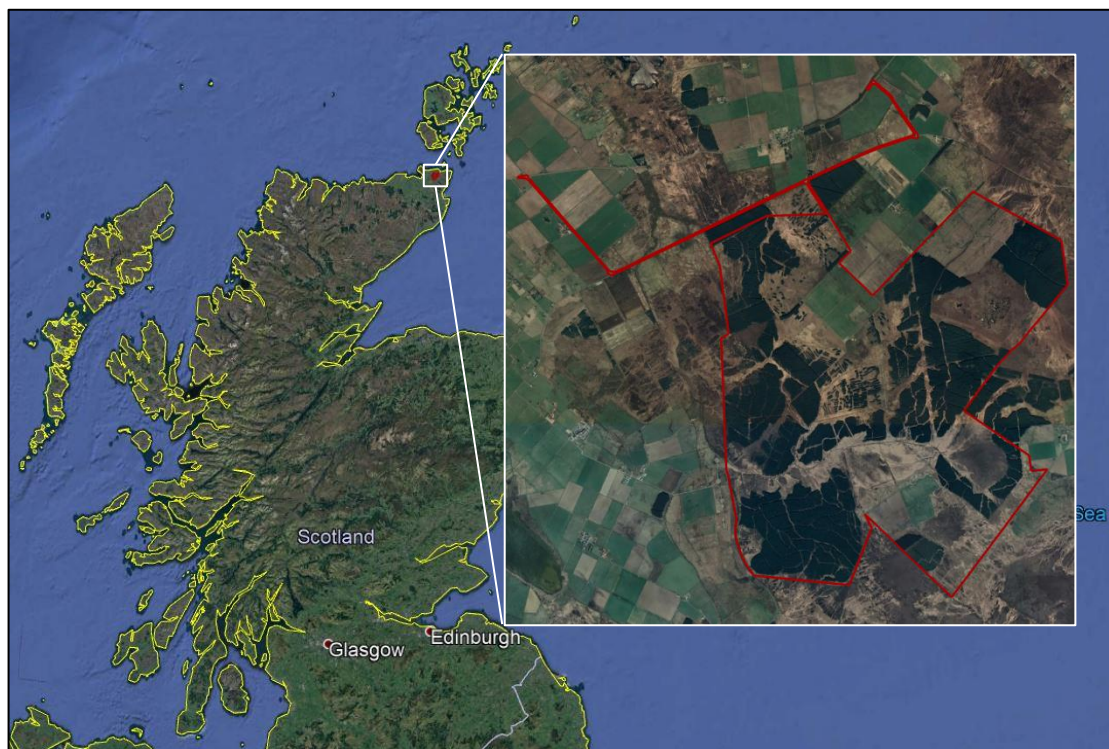


Figure 1 Proposed development location

² Source: Copyright © 2021 Google.

2.3 Proposed Development Layout

The locations of the proposed wind turbines are shown in Figure 2³ below. The wind turbine coordinate and height details are presented in Appendix A.



Figure 2 Proposed development layout

³ Source: Copyright © 2021 Google.

3 SHADOW FLICKER

3.1 Overview

Rotating wind turbine blades can cause brightness levels to vary periodically at locations where they obstruct the Sun's rays. This can result in a nuisance when the shadow is cast over the windows of residential properties. This intermittent shadow is described by the term 'shadow flicker' and it can be a cause of annoyance at residences near onshore wind turbines if it occurs for a significant period of time during the year⁴.

3.2 Guidance Overview

There are various sources of guidance with regard to shadow flicker impacts caused by wind turbines. The most relevant extracts have been presented and summarised in Table 2 below. However, the material regarding shadow flicker is quite extensive and not all aspects have been summarised here. The UK shadow flicker information is presented for reference to provide technical context.

Source	Extract	Remarks
Parsons Brinckerhoff, 2011 - <i>Update of UK Shadow Flicker Evidence Base</i>	This report presents an update of the evidence base which has been produced by carrying out a thorough review of international guidance on shadow flicker, an academic literature review and by investigating current assessment methodologies employed by developers and case study evidence. Consultation (by means of a questionnaire) was carried out with stakeholders in the UK onshore wind farm industry including developers, consultants and Local Planning Authorities (LPAs). This exercise was used to gauge their opinion and operational experience with shadow flicker, current guidance and the mitigation strategies that can and have been implemented.	The report was read and understood by Pager Power and provides context for flicker reports.

⁴ No significant negative health effects are anticipated. See Table 2.

Source	Extract	Remarks
<p>Parsons Brinckerhoff, 2011 – <i>Update of UK Shadow Flicker Evidence Base</i></p>	<p>The three key computer models used by the industry are WindPro, WindFarm and Windfarmer. It has been shown that the outputs of these packages do not have significant differences between them. All computer model assessment methods use a “worst case scenario” approach and don’t consider “realistic” factors such as wind speed and cloud cover which can reduce the duration of the shadow flicker impact.</p>	<p>Pager Power uses WindFarm software for its analysis.</p> <p>The exclusion of variable environmental factors within the model (such as cloud cover) produces the conservative results as shown in this report.</p>
	<p>Mitigation measures which have been employed to operational wind farms such as turbine shut down strategies, have proved very successful, to the extent that shadow flicker cannot be considered to be a major issue in the UK.</p>	<p>-</p>
	<p>Companion Guide to PPS22 makes the following statements:</p> <ul style="list-style-type: none"> • Shadow flicker only occurs inside buildings where the flicker appears through a narrow window opening; • Only properties within 130 degrees either side of north of the turbines can be affected at UK latitudes; <p>Shadow flicker has been proven to occur only within ten rotor diameters of a turbine position.</p>	<p>Note that this guidance was officially withdrawn as of March 2014 however the technical context pertaining to shadow flicker is still relevant for the purpose of this report.</p>

Source	Extract	Remarks
Parsons Brinckerhoff, 2011 – Update of UK Shadow Flicker Evidence Base	On health: <i>'On health effects and nuisance of the shadow flicker effect, it is considered that the frequency of the flickering caused by the wind turbine rotation is such that it should not cause a significant risk to health. Mitigation measures which have been employed to operational wind farms such as turbine shut down strategies, have proved very successful, to the extent that shadow flicker can not be considered to be a major issue in the UK.'</i>	-
	[Onshore Wind Energy Planning Conditions Guidance Note, Renewables Advisory Board and BERR (2007)] states that only dwellings within 130 degrees either side of north relative to a turbine can be affected and the shadow can be experienced only within 10 rotor diameters of the wind farm.	Secondary source presented within the Parson Brinckerhoff report.
Department for Communities & Local Government (July 2013): Planning practice guidance for renewable and low carbon energy.	Under certain combinations of geographical position and time of day, the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the impact is known as 'shadow flicker'. Only properties within 130 degrees either side of north, relative to the turbines.	This document replaced 'Planning for renewable energy: a companion guide to PPS22'. It should be noted that no maximum distance is given within this document.

Table 2 Guidance – shadow flicker

3.3 Discussion – 10 Rotor Diameter Exclusion Zone

It is common to use 10 rotor diameters as a maximum limit within which significant shadow flicker effects can occur. The validity of this limit is discussed at length within the relevant literature⁵. The guidance on this particular criterion varies in different documents and countries, with some stating that effects can only occur within this distance and others stating that this is a general rule or that the risk beyond this distance is low.

Pager Power generally considers receptors within 10 rotor diameters. This makes the 10 rotor diameter zone for each turbine measure out to 1,320m from the turbine (shown in section 4). This is considered an appropriate zone for potentially significant effects based on the available guidance and because other features of the modelling are highly conservative⁶ as set out in Table 2.

In this instance, the 50m micro-siting allowance has also been considered. Individual measurements have been taken for each dwelling near to the boundary to determine whether the dwellings are within 50m of the 10 rotor diameter zone.

3.4 Acceptable Limits

There is no formal limit on the amount of shadow flicker that is considered acceptable within the UK.

Other European countries do have limits, and these vary from one country to another⁷. A typical limit, which has been utilised in Northern Ireland, Republic of Ireland, Germany and Belgium, is 30 hours per year with a maximum of 30 minutes per day. Since there is no formal guidance on this subject in the UK, the discussion of the results relative to these limits is for reference purposes only.

If shadow flicker effects are predicted beyond this limit, mitigation may be required to eradicate the occurrence of shadow flicker. This is typically controlled by remote automatic wind turbine shutdown so that in effect, no neighbouring property will experience the occurrence of shadow flicker beyond the limits specified above. There are two approaches to mitigation:

- Complete removal of effects;
- Reduction of any effects to the acceptable limit specified above.

Shadow flicker effects can only occur under specific conditions so, in reality, turbine shutdown may not be required to eliminate effects i.e. shadow flicker cannot occur if the weather at the time of predicted effects is not clear and sunny or if the rotor is not face on to the dwelling.

⁵ See Table 2 for references.

⁶ For example the assumption that all properties have a single window facing the development and ignoring potential cloud cover or low wind speeds that could reduce the effects.

⁷ Parsons Brinckerhoff (2011): *Update of UK Shadow Flicker Evidence Base*.

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

The following section presents the assessed dwelling receptors.

4.2 Assessed Receptors

Dwelling receptors have been identified in the area surrounding the proposed wind development. Figures 3-8⁸ on the following pages shows the dwellings considered⁹ for shadow flicker analysis and turbine locations, specifically:

- The turbine positions (circular icons);
- The 10-rotor diameter zone (1,320m radius) relative to the turbines (orange area and outline);
- Consideration of identified dwellings near to the 10-rotor diameter zone with reference to the 50m micrositing allowance (dwellings 21, 22, 26 and 27).

Dwelling details, including the distance to the nearest turbine, are shown in Appendix A.

⁸ Source: Aerial image copyright © 2020 Google.

⁹ Provided by the developer.

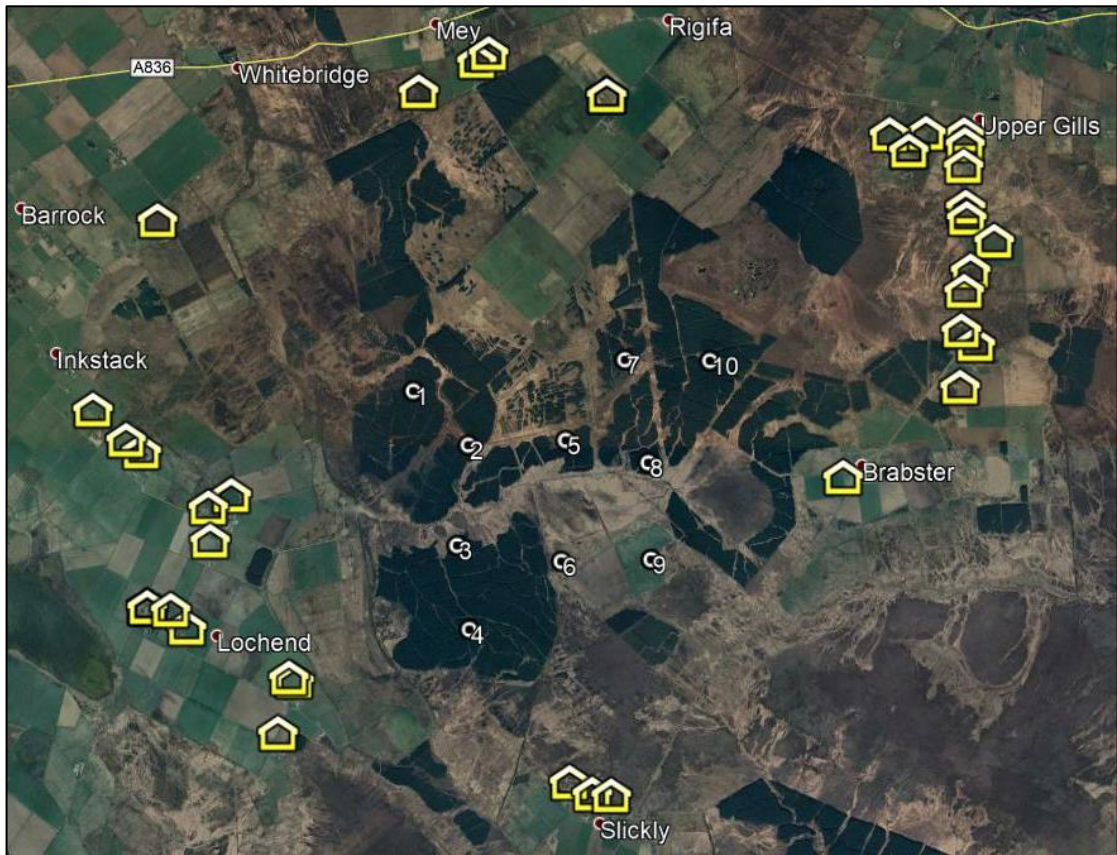


Figure 3 Identified dwelling receptors consider for the assessment

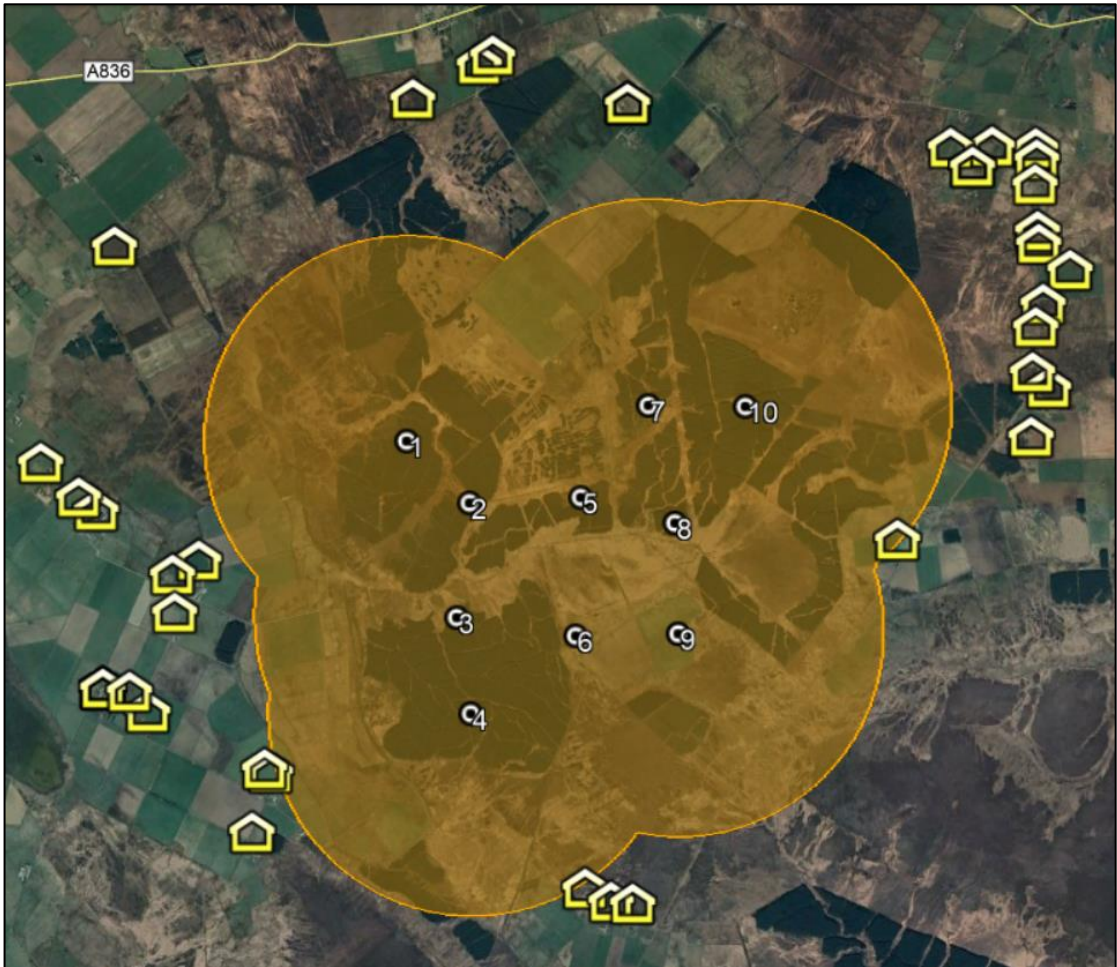


Figure 4 Identified dwelling receptors considered for the assessment with the 10 rotor diameter zone

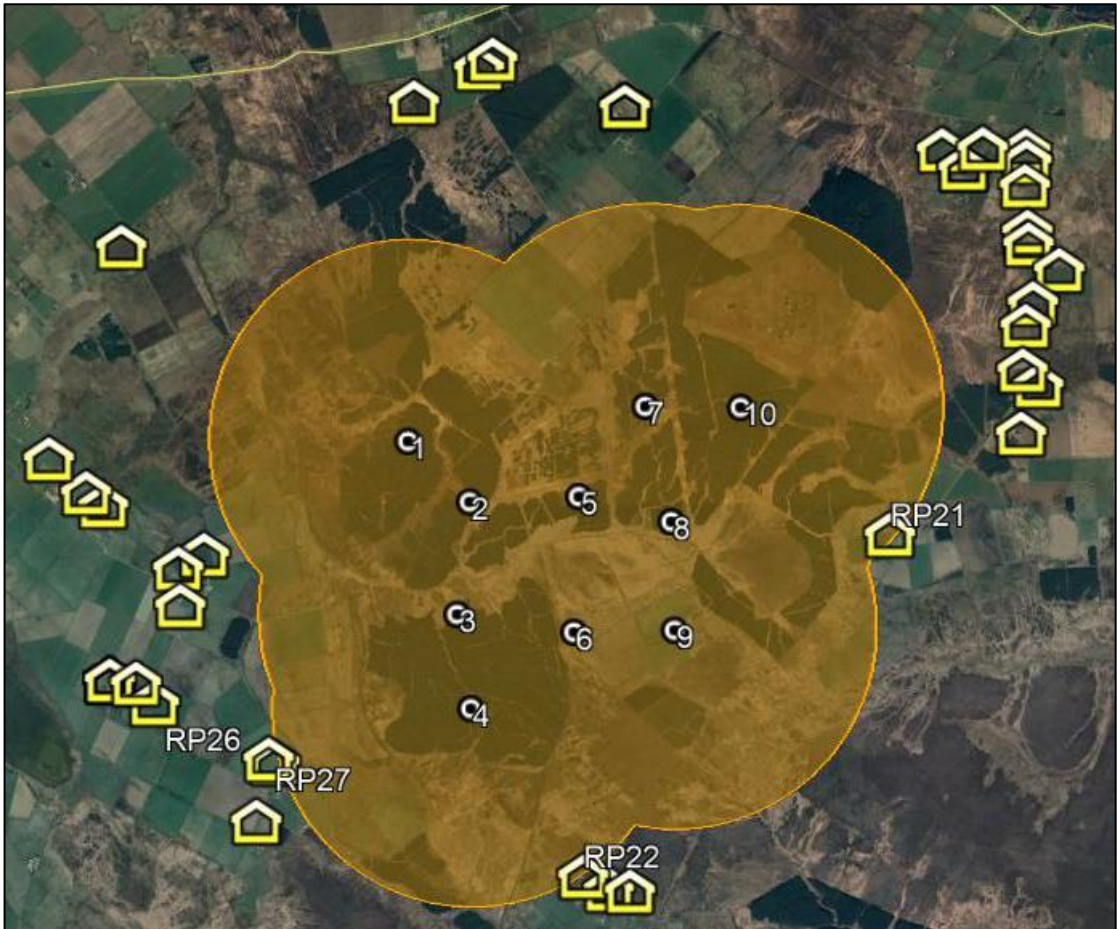


Figure 5 Identified dwellings 21, 22, 26 and 27 located close to but outside the 10 rotor diameter zone



Figure 6 Dwelling 21 and relative distance to the 10 rotor diameter zone



Figure 7 Dwelling 22 and relative distance to the 10 rotor diameter zone



Figure 8 Dwellings 26 and 27, and relative distance to the 10 rotor diameter zone

5 TECHNICAL ASSESSMENT – SHADOW FLICKER EFFECTS

5.1 Overview

The receptor identification analysis has shown that no identified dwelling receptors lie within the 10 rotor diameter zone.

Furthermore, no dwellings are located within the 50m buffer applied to allow for wind turbine micro-siting.

5.2 Shadow Flicker Analysis Conclusions

In accordance with the industry standard shadow flicker methodology, there will be no significant shadow flicker effects requiring mitigation.

6 CUMULATIVE SHADOW FLICKER ASSESSMENT

6.1 Overview

The potential for cumulative shadow flicker impacts has been determined by considering the results of the shadow flicker analysis and identifying existing wind developments in the wider area.

6.2 Adjacent Wind Farms

Whilst there are operational wind farms in the vicinity of the proposed wind development (Lochend – consisting of four wind turbines, and Slickly – consisting of 11 wind turbines), because no significant shadow flicker effects are predicted for the proposed wind development in isolation (because all identified dwellings are beyond 10 rotor diameter plus the 50m micro-siting allowance), no cumulative impacts are possible.

6.3 Cumulative Assessment Conclusions

No cumulative shadow flicker impacts are possible with respect to the proposed wind development and any existing wind developments surrounding it.

7 MITIGATION MEASURES

7.1 Overview

No mitigation measures are required because no significant shadow flicker impacts are possible. There is therefore no requirement for mitigation.

8 CONCLUSIONS

8.1 Results Overview

The overall conclusions are presented below.

- 41 surrounding dwellings have been considered within this assessment;
- All dwellings are outside of the 10 rotor diameter zone (1,320m radius from the turbines)
- All dwellings are outside the additional 50m buffer zone applied (on top of the 10 rotor diameter zone), which allows for micro-siting of the turbines;
- No dwellings have therefore required detailed shadow flicker modelling as all are outside of the associated zones where detailed analysis is required.

8.2 Shadow Flicker Analysis Conclusions

In accordance with the industry standard shadow flicker methodology, there will be no significant shadow flicker effects at any of the identified dwellings, either in isolation or cumulatively, requiring mitigation.

APPENDIX A – DWELLING INFORMATION

The table below shows the dwelling information incorporated into the modelling (OSGB36 Easting and Northing).

No.	Property Name	Distance to nearest wind turbine (m)	Direction to nearest wind turbine	Easting	Northing
RP1	West Lodge	2311	T1 South south east	328897	972260
RP2	Woodlands	2327	T7 south west	328985	972316
RP3	No 2 Cottage, Phillips Mains	1787	T7 south south east	329851	971987
RP4	No 3 Cottage, Phillips Mains	1787	T7 south south east	329851	971987
RP5	1 Phillips Mains	1787	T7 south south east	329851	971987
RP6	Bridle Way	1997	T10 south west	331931	971663
RP7	Shean Cottage	2007	T10 south west	332070	971538
RP8	Widdershins Cottage	2007	T10 south west	332070	971538
RP9	Bencorragh House	2190	T10 south west	332200	971667
RP10	Clairlea	2396	T10 south west	332482	971653
RP11	Hazel Cottage	2356	T10 south west	332487	971579
RP12	Ha of Gills	2252	T10 south west	332473	971417
RP13	Kandahar	2110	T10 south west	332482	971116
RP14	Belvedere	2080	T10 south west	332487	971033
RP15	Heather Moor	2204	T10 south west	332686	970861
RP16	Torshamn	1972	T10 west south west	332506	970644
RP17	Sandbank	1893	T10 west	332455	970495

No.	Property Name	Distance to nearest wind turbine (m)	Direction to nearest wind turbine	Easting	Northing
RP18	The Myre	1839	T10 west	332427	970204
RP19	Brabster Farm Cottage	1943	T10 west	332529	970102
RP20	Davie's Croft	1867	T10 west	332413	969791
RP21	Old Schoolhouse	1413	T10 north west	331542	969143
RP22	Slickly	1485	T4 north west	329486	966933
RP23	Slickly Farm	1645	T4 north west	329652	966845
RP24	Mooredge	1734	T4 north west	329791	966831
RP25	9 Lochend Holding	1702	T4 north east	327341	967332
RP26	10 Lochend Holding	1442	T4 north east	327429	967739
RP27	The Whitehouse	1416	T4 north east	327466	967716
RP28	Morven View	2105	T4 east north east	326679	968119
RP29	4 Lochend Holding	2381	T4 east	326391	968277
RP30	5 Lochend Holding	2381	T4 east	326391	968277
RP31	6 Lochend Holding	2381	T4 east	326391	968277
RP32	8 Lochend Holding	2381	T4 east	326391	968277
RP33	7 Lochend Holding	2218	T4 east	326563	968253
RP34	Penny Falls	1839	T3 east	326864	968758
RP35	3 Lochend Holding	1838	T3 east	326855	969004

No.	Property Name	Distance to nearest wind turbine (m)	Direction to nearest wind turbine	Easting	Northing
RP36	2 Lochend Holding	1647	T1 north east	327026	969092
RP37	Hollandmake	2110	T1 east north east	326368	969425
RP38	Torvean	2196	T1 east north east	326257	969513
RP39	Unnamed property	2396	T1 east north east	326016	969740
RP40	Broadlean	2192	T1 south east	326516	971130
RP41	Kittiwake Cottage	2044	T1 south	328462	972047

Dwelling details

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