Pennant Walters

GLANLLYNFI GARTH WIND FARM

Draft Environmental Statement

Chapter 14 - Shadow Flicker

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14 Shadow Flicker

14.1 Introduction

14.1.1. This chapter presents the assessment of the likely significant effects of the Proposed Development with respect to shadow flicker. The assessment is based on information obtained to date. It should be read in conjunction with the Proposed Development description provided in **Chapter 4: Development Description**.

14.1.2. This chapter describes:

- the legislation, policy and technical guidance that has informed the assessment (**Section 14.2**);
- consultation and engagement that has been undertaken and how comments from consultees relating to shadow flicker have been addressed (**Section 14.3**);
- the methods used for baseline data gathering (**Section 14.4**);
- overall baseline (**Section 14.5**);
- embedded measures relevant to shadow flicker (**Section 14.6**);
- the scope of the assessment for shadow flicker (**Section 14.7**);
- the methods used for the assessment (**Section 14.8**);
- the assessment of shadow flicker effects (**Section 14.9**);
- assessment of cumulative (inter-project) effects (**Section 14.10**);
- a summary of the significance conclusions (**Section 14.11**);

Limitations and assumptions

14.1.3. The information provided in this Draft Environmental Statement (ES) is based on current information; the final assessment of likely significant effects will be reported in the ES. The Draft ES has been produced to fulfil the Pre-Application Consultation (PAC) duties of the Applicant and enable consultees to develop an informed view of the likely significant effects of the Proposed Development.

14.1.4. The properties considered in the shadow flicker assessment were not visited because a realistic worst-case scenario has been assessed. The realistic worse worst-case scenario assumes that for all properties, one window at ground level is always perpendicular to the wind turbines (e.g. facing the wind turbines). The model and results therefore assume that at least one window in each property will always be oriented in a direction that allows shadow flicker effects to occur. In reality, some properties may not have windows oriented in a direction that allows shadow flicker effects to occur.

14.1.5. There are no limitations relating to shadow flicker that affect the robustness of the assessment of the potential likely significant effects of the Proposed Development.

14.2 Relevant legislation, planning policy and technical guidance

14.2.1. This section identifies the legislation, planning policy and technical guidance that has informed the assessment of effects with respect to shadow flicker. Further information on policies relevant to the Proposed Development is provided in **Chapter 5: Legislation and Policy**.

Legislation

14.2.2. There is no current legislation in Wales that addresses shadow flicker specifically. This assessment will therefore rely on planning policy and technical guidance discussed in the subsequent report sections.

Planning Policy

14.2.3. A summary of the relevant national and local planning policy is given in **Table 14.1.**

Table 14.1 Planning policy relevant to the shadow flicker assessment.

Technical guidance document	Context
National planning policy	
Future Wales: The National Plan 2040[1]	With respect to shadow flicker, this states: "*Policy 18 – Renewable and Low Carbon Energy Developments of National Significance* *… 7. there are no unacceptable adverse impacts by way of shadow flicker, noise, reflected light, air quality or electromagnetic disturbance*;"
Technical Advice Note (TAN) 8: Planning for Renewable Energy (2005)[2] – Para 2.32 (revoked however used as a guide for this assessment)	*"Under particular circumstances the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. The shadow flicks on and off as the blades rotate. This can be disturbing for the affected residents or even have the potential of being a health problem for people who are photo-sensitive epileptics.* *The problem is only seasonal and lasts for a few hours per day but needs to be investigated where any potential exists. Developers should provide an analysis of the potential shadow flicker impacting upon nearby properties".*

[1] *Welsh Government (2021). Future Wales: The National Plan 2040. [online] Available at: https://gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf [Accessed 22nd June 2026].*

[2] *Welsh Government (2005). Planning Policy Wales Technical Advice Note 8: Planning for Renewable Energy. [online] Available at: https://www.gov.wales/sites/default/files/publications/2018-09/tan8-renewable-energy_0.pdf [accessed 22nd June 2026]*

Technical guidance document	Context
Local planning policy	
Bridgend County Borough: Local Development Plan 2018-2033 (adopted March 2024)[3]	Policy SP3, Good Design and Sustainable Placemaking discusses viability and amenity of neighbouring uses, ensuring occupiers are not adversely affected. Policy SP3 also requires development to avoid or minimise noise, air, and soil and water pollution, but does not discuss shadow flicker specifically.

14.2.4. In summary, none of the active or revoked planning policies at the national or local level provide a prescribed methodology for the assessment of shadow flicker.

Technical Guidance

14.2.5. A summary of the technical guidance for shadow flicker is given in **Table 14.2**.

Table 14.2 Technical guidance relevant to the shadow flicker assessment.

Technical guidance document	Context
Best Practice Guidance to Planning Policy Statement 18 (PPS 18) Renewable Energy (Northern Ireland Department of the Environment, 2009)[4]	Whilst not strictly applicable in a Welsh context, the guidance in Northern Ireland provided in the draft Best Practice Guidance to Planning Policy Statement 18 (PPS 18) Renewable Energy (Northern Ireland Department of the Environment, 2009) is noteworthy. The draft guidance reaffirms the advice provided by DECC (2011) and the Welsh Government but further recommends that "*shadow flicker at neighbouring offices and dwellings within 500 m should not exceed 30 hours per year or 30 minutes per day*." The recommendation is based on a European Union sponsored study undertaken by Predac (2004), an organisation that promotes best practice in energy use and supply.
Department of Energy and Climate Change, Update of UK Shadow Flicker Evidence Base, 2011[5]	Provides an evidence base supporting the commonly adopted quantitative thresholds and confirms that predicted shadow flicker effects are generally manageable through appropriate siting, assessment and mitigation. The technical conclusions are considered transferable and consistent with good practice. The report states that…. *"the 10 rotor diameter rule has been widely accepted across different European countries, and is deemed to be an appropriate assessment area, although there is potentially a need to differentiate between appropriate*

[3] *Bridgend County Borough (2024). Local Development Plan 2018-2033. [online] Available at: https://www.bridgend.gov.uk/media/izcfgp1f/written-statement.pdf [accessed 22nd June 2026]*
[4] *Northern Ireland Department of the Environment (2009). Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy'. (online) Available at: https://www.infrastructure-ni.gov.uk/sites/default/files/publications/infrastructure/Best%20Practice%20Guidance%20to%20PPS%2018%20-%20Renewable%20Energy_0.pdf [Accessed May 2026].*
[5] *Department of Energy and Climate Change (2010). Update of UK Shadow Flicker evidence base (online). Available at: https://assets.publishing.service.gov.uk/media/5a79770bed915d0422068aa3/1416-update-uk-shadow-flicker-evidence-base.pdf (Accessed May 2026).*

Technical guidance document	Context
	assessment areas at different latitudes. This is an area where the scientific evidence base could be readdressed." *"Across Europe and further afield, different countries have varying guidance on shadow flicker assessment. In all countries investigated where shadow flicker is a perceived issue, it falls under the remit of "best practice" guidelines rather than regulatory policy. Some countries have adopted quantitative guidance, with limits on the flicker that can result from a development."* *"Mitigation measures adopted by developers have been successful. Careful site design to eliminate shadow impacts is important, with mitigation measures such as turbine shut down systems being used regularly. These systems are acceptable for all parties, and by virtue of their success, the issue of shadow flicker appears to be minor. Mitigation measures are often put into planning conditions."*

14.2.6. It should be noted that the 10 rotor diameter study area and quantitative thresholds of 30 minutes per day or 30 hours per year (worst-case and referenced above) are frequently used as part of industry good practise methodologies in the UK, internationally and is used in this shadow flicker assessment (see Study Area and Spatial Extent in **Section 14.4** and Significance Evaluation Methodology in **Section 14.8**).

14.3 Consultation and Engagement

Overview

14.3.1. The assessment has been informed by consultation responses and ongoing stakeholder engagement. An overview of the approach to consultation is provided in **Section 2.4** of **Chapter2 2: Approach to Environmental Impact Assessment (EIA)**.

Scoping Opinion

14.3.2. A Scoping Direction was issued by the Planning Inspectorate, on behalf of the Welsh Ministers, on 12 June 2026. A summary of the relevant responses received in the Scoping Opinion in relation to shadow flicker and confirmation of how these have been addressed within the assessment to date is presented in **Table 14.3.**

Table 14.3 Summary of EIA Scoping Direction Responses for shadow flicker

Consultee	Consideration	How addressed in this Draft ES
PEDW	"*Shadow Flicker: PEDW notes that in 'Review of Light and Shadow Effects from Wind Turbines in Scotland' (https://www.climatexchange.org.uk/projects/review-*	The study area is considered further in **Section 14.4**

Consultee	Consideration	How addressed in this Draft ES
	of-light-and-shadow-effects-from-wind-turbines-in-scotland/, L.U.C. for climateXchange, 2017) it was found that "there is a lack of evidence to support the use of ten rotor diameters as a cut off, and this is entirely down to misinterpretation of the original reference to this distance."	
PEDW	*"BCBC's Environmental Health Officer states that; 'I have reviewed the scoping opinion report for the above windfarm and am in agreement with what the Applicant proposes to scope in and out of the EIA with respect to noise and shadow flicker.' PEDW is in agreement with BCBC."* *"PEDW welcomes that shadow flicker is scoped into the ES. Please note the comments regarding Shadow Flicker in Section 6 of this Direction."* Section 6 refers to the study area of 10 rotor diameters.	The study area is considered further in **Section 14.4**

Technical Engagement

14.3.3. There has been no technical engagement with consultees for the shadow flicker assessment.

14.4 Data gathering methodology

Study area and models

14.4.1. The shadow flicker assessment comprises numerical modelling of the proposed turbines and receptors within the defined Study Area. It is noted that whilst there are several computer models available, the Department of Energy and Climate Change (DECC) study (2011)[6] confirms that there are limited differences between outputs of the various packages. For shadow flicker assessments, one of the industry standard software packages, WindPro Version 4.2 has been used.

14.4.2. The calculations from this assessment process assume a worst-case scenario based on the sun shining during all daylight hours over the course of a year, no obscuring features (such as trees, hedges, other buildings) being present, the face of the rotor always being aligned towards the dwelling, one window is always facing the wind turbine(s), and that the rotor is always turning (i.e., the wind is always blowing between 4 m/s and 25 m/s, and no account is taken of shut down periods for maintenance). This methodology yields

[6] *Department of Energy and Climate Change (2010). Update of UK Shadow Flicker evidence base*

a theoretical maximum indication of potential shadow flicker incidence, together with the times of day, and dates during the year when potential incidence may occur. The model factors in topography and landform 'blocking' of shadow flicker, assessing visibility from the receptor to the wind turbine and any intervening landform between the sun and turbine at each time interval.

14.4.3. The software performs calculations to determine the position of the sun throughout the year, and thus during what times of day it will theoretically cast a shadow across the windows of nearby houses. The shadow flicker model inputs are as follows:

- the locations of all residential properties as identified by Ordnance Survey (OS) Address Base within ten times the rotor diameter (including an allowance of 50m for micrositing);
- the surrounding topography (Ordnance Survey Digital Terrain Model); and
- the locations and dimensions of the turbines.

Spatial Extent

14.4.4. The comments received from PEDW in the scoping direction relating to assessment distance of shadow flicker effects have been noted, as well as reference to the LUC (2017) research paper on the 'Review of Light and Shadow Effects from Wind Turbines in Scotland'[7].

14.4.5. It is considered that it is appropriate and proportionate to assess shadow flicker effects within 10 rotor diameters of the proposed turbines, consistent with the established UK evidence base and commonly applied assessment practice. The DECC evidence base concluded that assessment within 10 rotor diameters is an acceptable approach and further stated that the 10 rotor diameter rule is deemed to be an appropriate assessment area, whilst acknowledging that latitude may be a factor warranting future scientific review. The 10 rotor diameter approach is an established feature of UK best practice and is reflected in Irish guidance[8]; elsewhere in Europe, shadow flicker control is commonly addressed through alternative fixed-distance or exposure-based criteria[9].

14.4.6. There is also a clear physical basis for retaining 10 rotor diameters as a proportionate Study Area. The DECC evidence base explains that the shadow flicker effect becomes less pronounced with increasing distance because there are fewer occasions when the sun is low enough to cast a long shadow, low sun is more likely to be obscured by cloud or intervening features, and the rotor shadow passes more quickly over the land. It further states that, at distance, turbine blades increasingly only partly mask the sun, thereby substantially weakening the shadow, such that only a very weak effect is observed at greater separation distances. In this context, a blanket requirement to extend the Study Area beyond 10 rotor diameters would risk placing undue weight on highly conservative

[7] LUC (2017). Review of Light and Shadow Effects from Wind Turbines in Scotland. Available at: https://www.climatexchange.org.uk/wp-content/uploads/2023/09/light_and_shadow_effects_from_wind_turbines_in_scotland_stages_1_and_2.pdf (accessed May 2026)
[8] Department of Housing, Local Government and Heritage (2006). Wind Energy Development Guidelines (online). https://www.gov.ie/en/department-of-housing-local-government-and-heritage/publications/wind-energy-development-guidelines-2006/ (Accessed May 2026)
[9] Bund/Länder-Arbeitsgemeinschaft für Immissionsschutz (LAI) (2020) Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windkraftanlagen (WKA-Schattenwurfhinweise), Aktualisierung 2019, Stand 23.01.2020. Available at: https://www.lai-immissionsschutz.de/documents/wka_schattenwurfhinweise_stand_23_1588595757.01.pdf (Accessed: May 2026).

theoretical effects that are materially weaker and less likely to give rise to significant effects in EIA terms.

14.4.7. The report prepared for ClimateXChange by LUC and Pager Power[7] is acknowledged; however, that document is best understood as a research review intended to inform possible future Scottish guidance, rather than adopted planning policy in Wales. Whilst it questions the robustness of relying on 10 rotor diameters as a universal distance rule, it does not establish a policy requirement for all developments to extend assessment beyond 10 rotor diameters; rather, it recommends that any future refinement should focus on exposure thresholds, receptor sensitivity, and improved modelling, supported by further research. Read in that context, the current evidence does not support a blanket departure from the accepted industry standard 10 rotor diameter approach, particularly where there is limited evidence of widespread operational problems and where identified issues have generally been capable of effective mitigation through established measures such as turbine shut-down protocols.

14.4.8. Taking the above into account, this shadow flicker assessment has defined the spatial scope to be 10 rotor diameters from any proposed wind turbine in line with industry good practice.

14.4.9. As outlined in **Section 14.2**, it is considered that shadow flicker does not have a significant effect at properties located at a distance greater than ten rotor diameters from the wind turbines. The turbines under consideration at the Proposed Development have rotor diameters of up to 150 m, meaning a study area of 1,500 m. The shadow flicker assessment has allowed 50 m for micrositing, giving a total Study Area of 1,550 m.

14.4.10. Properties falling within this Study Area will be assessed with regards to the potential to experience shadow flicker. The Study Area is shown in **Figure 14.1,** with further detail in **Figure 14.2** to **Figure 14.5**.

Desk Study

14.4.11. A summary of the organisations that have supplied data, together with the nature of that data is outlined in **Table 14.4.**

Table 14.4 Data sources used to inform the shadow flicker assessment

Organisation	Data source	Data provided
Ordnance Survey	Ordnance Survey AddressBase Plus[10]	Residential properties - location in relation to Proposed Development.
Ordnance Survey	OS Terrain 5[11]	Topographic data

Survey work

14.4.12. No survey work was undertaken for this shadow flicker assessment.

[10] Data acquired through eMapSite. Product details can be found at: Ordnance Survey (2026). AddressBase data products and support (online). Available at: https://www.ordnancesurvey.co.uk/products/addressbase (Accessed July 2026).
[11] Data acquired through eMapSite. Product details can be found at: Ordnance Survey (2026). OS Terrain 5 Documentation (online). Available at: https://docs.os.uk/os-downloads/products/land-and-terrain-portfolio/os-terrain-5 (Accessed July 2026).

14.5 Overall baseline

14.5.1. This section summaries the baseline shadow flicker conditions determined through the course of desk-based investigations. This section identifies and evaluates those shadow flicker features/receptors that lie within the relevant Study Area and which are pertinent in the context of the Proposed Development.

Current baseline

14.5.2. None of the properties considered in this assessment currently experience shadow flicker from other wind farm developments (see **Section 14.10** for more detail on other wind farms and cumulative effects).

Future baseline

14.5.3. On the basis of the information currently available, no changes to the baseline conditions are anticipated in the event that the Proposed Development does not proceed.

14.6 Embedded measures

14.6.1. There are no UK guidelines which quantify what exposure levels to shadow flicker would be acceptable. Therefore, where particular combinations of circumstances arise that have the potential for nuisance (particularly where rooms affected are in regular occupancy and the effect proves to be a frequent occurrence in reality), measures may be required to reduce the level of exposure to acceptable levels.

14.6.2. If shadow flicker effects occur in practice at a particular occupied building, it does not immediately follow that additional mitigation is required. Such effects would need to occur in a room that was occupied at the times of occurrence and for a duration that caused a nuisance. For example, if an effect was predicted to occur for a three-week period in the early hours of the morning in a room unlikely to be occupied at that time, with each occurrence lasting just a few minutes, then it is unlikely that mitigation measures would be needed.

14.6.3. However, until the turbine locations and technical parameters are precisely defined (following micrositing and turbine selection through competitive tender activities), and the wind turbines are operating, neither the requirement for, nor the exact details of mitigation can be finalised.

14.6.4. The Applicant is committed to installing a shadow flicker impact control module prior to operation on turbines which have the potential to cause shadow flicker on nearby properties. Therefore if, following a complaint and appropriate investigation, shadow flicker is confirmed to result in a loss of residential amenity at any location, the technical mitigation measures built into these turbines would be activated. This covers all properties that could experience shadow flicker.

14.6.5. The shadow flicker control module consists of bespoke software, a clock, a timer, a switch, a wind direction sensor and a light sensor. The module can control a specific turbine (or turbines) which would be programmed to shut down on specific dates at specific times when the sun is bright enough, there is sufficient wind to rotate the blades,

and the wind direction is such that nuisance shadow flicker could occur. There is no specific UK guidance regarding what level of light is sufficient to cause a shadow flicker event. However, the actual light level that would trigger a turbine shut down can be manually configured onsite, following installation, to reflect local conditions.

14.6.6. A planning condition would provide for an appropriate form of mitigation to ensure that any complaints would be investigated within a reasonable timescale and that the rectification of any shadow flicker problem that is substantiated would be implemented promptly and effectively. As noted previously, the DECC guidance (2011)[12] states that *"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".*

14.6.7. **Table 14.5** outlines how embedded measures will influence the shadow flicker assessment.

Table 14.5 Summary of the embedded environmental measures

Receptor	Potential changes and effects	Embedded measures	Compliance mechanism
Operation			
Residential occupied buildings within the study area	Experiencing shadow flicker effects.	Implementation of a shadow flicker control module will reduce effects to an acceptable level.	DNS planning condition

14.7 Scope of the assessment

14.7.1. The approach to the shadow flicker assessment as set out in **Section 14.8** was outlined in the Scoping Report (see **Appendix 14A**). It was stated that following determination of the final turbine layout for the Proposed Development, an assessment would be carried out to determine whether shadow flicker could be experienced at receptors in the vicinity of the Proposed Development.

Spatial Scope

14.7.2. The spatial scope of the assessment of shadow flicker covers the area of the Proposed Development contained within the Development Site, together with the Zones of Influence (ZoIs) that have formed the basis of the study area described in **Section 14.4.** In short, the spatial scope extends to 10 rotor diameters plus 50 m from any proposed wind turbine (accounting for micrositing).

Temporal Scope

14.7.3. Shadow flicker is an operational effect of the Proposed Development and is not present during construction or decommissioning. Therefore, the temporal scope of the

[12] *Department of Energy and Climate Change (2010). Update of UK Shadow Flicker evidence base*

assessment of shadow flicker is consistent with the period over which the development would be carried out and therefore covers the operational period of the wind farm.

Potential Receptors

14.7.4. There are 1,138 residential receptors, as identified from OS AddressBase, in the Study Area that have been considered in this assessment. For simplicity of reporting in the main body of this chapter, where several receptors are present in a small geographic area they have been grouped. Details on how grouped receptors are assessed is provided in **Section 14.8**. A full list of all receptors and their grouping is provided in **Appendix 14A**. The principal shadow flicker receptors, which includes grouped receptors and isolated receptors that have been identified as being potentially subject to effects are summarised in **Table 14.6** with 118 receptors representing 1,138 properties. **Figure 14.1** to **Figure 14.5** show the receptor locations and receptor groups as summarised in **Table 14.6.**

14.7.5. The receptors referenced in this Draft ES Chapter comprise two separate identifiers. Each of the 1,138 receptors assessed has a unique identifier, “Unique receptor ID”. For summary reporting and where some receptors have been grouped, a separate designation has been used “Grouped receptor ID”. Grouped receptor ID contains some unique receptors that have been assessed individually, where they are geographically separate from other receptors as well as grouped receptors. **Appendix 14A** provides a full inventory as to how these designations are related.

Table 14.6 Shadow flicker receptors subject to potential effects

Grouped Receptor ID	Receptor Name and Address[13]	Easting	Northing
a	CWRT Y MWNWS FARM, CWMDU ROAD, CF34 0DW	285821	191956
b	LLUEST FARM, LLUEST FARM ACCESS FROM A4064, CF32 8HJ	290880	189729
c	17, BEECH ROAD, CF32 8AJ	290598	189942
d	BRIDGE HOUSE, BRYN TERRACE, CF34 0EA	288252	188621
e	1, CWMDU ROAD, CF34 0DL	286660	191546
f	1 LLUEST COTTAGES, LLUEST COTTAGES, CF32 8LX	290550	189718
g	CELFYDDIFAN FARM, BRYN TERRACE LLETTY BRONGU TO GLANNANT ROW SHWT, CF32 8UE	288746	187930
h	DANYRHUG HOUSE, CWMDU ROAD, CF34 0DL	286503	191527
i	THE LONG HOUSE, CWMDU ROAD, CF34 0DH	287690	192084
j	91, HERMON ROAD, CF34 0SY	285457	193799
k	BLAEN-CWMDU FARM, CWMDU ROAD, CF34 0DH	287727	192128
l	CWMDU GANOL FARM, CWMDU ROAD, CF34 0DH	287821	191297
m	6 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288289	188616

[13] Note that for grouped receptors a representative point has been selected for visualisation. Where receptors have been assessed in isolation e.g. not grouped, the address of that receptor has been provided. For receptors in Table 14.6 that form part of a group, no address has been provided. See Appendix 14A for details of all receptors assessed and the addresses that form part of each group.

Grouped Receptor ID	Receptor Name and Address[13]	Easting	Northing
n	OAKFIELD HOUSE, STATION ROAD, CF34 9TF	287087	189099
o	BRYNDEFAID FARM, CWMDU ROAD, CF34 0DH	288237	191606
p	CYNHORDY FARM, BRYN TERRACE, CF34 0EA	288310	188992
q	2 THE BRACKENS, THE BRACKENS, CF34 0DY	288047	188727
r	TOR-Y-FRON FARM, BRYN TERRACE, CF34 0EA	288414	188886
s	COED-Y-GARTH HOUSE, MILL VIEW ESTATE, CF34 0DF	286994	189442
t	LLWYN-Y-BRAIN FARM, BRYN TERRACE LLETTY BRONGU TO GLANNANT ROW SHWT, CF32 8UE	288214	187982
u	BRYNDEFAID FARM, CWMDU ROAD, CF34 0DH	288245	191614
v	1 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288268	188633
w	18, BEECH ROAD, CF32 8AJ	290601	189949
x	MAES Y MARL, HERMON ROAD, CF34 0SY	285461	193813
y	TY GWYN BACH, EVANS TERRACE, CF34 0RG	285670	193855
z	11 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288309	188600
aa	CAPELBACH FARM, BRYN TERRACE, CF34 0EB	288431	188544
ab	2 LLUEST COTTAGES, LLUEST COTTAGES, CF32 8LX	290550	189711
ac	8 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288297	188611
ad	3 THE BRACKENS, THE BRACKENS, CF34 0DY	288069	188724
ae	5 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288285	188620
af	3 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288277	188626
ag	33, BANGOR TERRACE, CF34 0HU	285147	192502
ah	10 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288305	188604
ai	BROOKFIELD HOUSE, CWMDU ROAD, CF34 0DG	286968	191215
aj	1 THE BRACKENS, THE BRACKENS, CF34 0DY	288000	188707
ak	7 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288293	188614
al	9 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288301	188608
am	BLAEN-CWMDU, CWMDU ROAD, CF34 0DH	287723	192126
an	4 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288281	188623
ao	1A THE BRACKENS, THE BRACKENS, CF34 0DY	288021	188722
ap	21, STATION ROAD, CF34 9TF	287120	189055
aq	TONYBEILI FARM, STATION ROAD, CF34 9TF	287133	189126
ar	2 BRYN TERRACE, BRYN TERRACE, CF34 0EA	288272	188630
as	TYMAEN FARM, STATION ROAD SERVICE ROAD LEADING TO TY-MAEN, CF34 0EH	287279	189548
at	LLWYN Y GOG, STATION ROAD SERVICE ROAD LEADING TO TY-MAEN, CF34 0EH	287343	189649
au	BRAICH-Y-CYMMER FARM, BRAICH-Y-CYMER ROAD, CF32 8ER	290227	190923
av	32, BANGOR TERRACE, CF34 0HU	285148	192506

Grouped Receptor ID	Receptor Name and Address[13]	Easting	Northing
aw	GELLIHEBLYG, STATION ROAD TO BRYN TERRACE LLETTY BRONGU, CF34 0DT	287693	189603
ax	19, BEECH ROAD, CF32 8AJ	290606	189957
ay	16, BEECH ROAD, CF32 8AJ	290558	189908
az	STATION BUNGALOW, STATION ROAD TO BRYN TERRACE LLETTY BRONGU, CF34 0DY	288153	188703
ba	THE BUNGALOW, STATION ROAD TO BRYN TERRACE LLETTY BRONGU, CF34 0DY	288140	188633
bb	LLETY BRONGU FARM, STATION ROAD TO BRYN TERRACE LLETTY BRONGU, CF34 0DU	287481	188908
bc	BRYNRHUG FARM, CWMDU ROAD, CF34 0DL	286641	191838
bd	FFOS FARM, CWMDU ROAD, CF34 0DG	287436	191018
be	STATION ROAD SERVICE ROAD LEADING TO TY-MAEN	287796	190561
bf	STATION ROAD SERVICE ROAD LEADING TO TY-MAEN	287796	190561
bg	GRAIG-YR-HEIDOL FARM, MOEL GILAU, CF32 8UG	289196	188622
bh	STATION ROAD SERVICE ROAD LEADING TO TY-MAEN	287796	190561
bi	STATION ROAD SERVICE ROAD LEADING TO TY-MAEN	287796	190561
bj	BRYN LLEFRITH FARM, COEGNANT ROAD, CF34 0TN	285943	193543
bk	AXMOUTH HOUSE, BRYN COTTAGES, CF32 8PX	290746	189417
bl	PENLAN BUNGALOW, CUCKOO STREET, CF32 8DR	290680	190457
bm	BROOKSIDE COTTAGE, FENTON PLACE, CF32 8DN	290460	190746
bn	1 PENYBRYN BUNGALOWS, LLYNFI VIEW, CF34 0RF	285951	194008
bo	3 PENYBRYN BUNGALOWS, LLYNFI VIEW, CF34 0RF	285907	193988
bp	2, LLYNFI VIEW, CF34 0RE	285861	193996
bq	1, LLYNFI VIEW, CF34 0RE	285868	194005
br	2 PENYBRYN BUNGALOWS, LLYNFI VIEW, CF34 0RF	285961	194011
bs	18, GARWFECHAN ROAD, CF32 8BX	290265	189981
bt	NAZARETH CHAPEL HOUSE, BRYN VILLAS, CF32 8PX	290732	189368
bu	CWMCEDFYW FARM, MOEL GILAU, CF34 0EB	288906	188726
bv	MAESTEG COMPREHENSIVE SCHOOL, FFORDD DYSGUS, CF34 0LQ	285565	191658
bw	GELLI HIR FARM, BRYN TERRACE, CF34 0EA	288183	188993
bx	Grouped Receptor	285204	192658
by	Grouped Receptor	285253	192839
bz	Grouped Receptor	285173	192961
ca	Grouped Receptor	285276	193116
cb	Grouped Receptor	285333	193066
cc	Grouped Receptor	285387	193253
cd	Grouped Receptor	285437	193357

Grouped Receptor ID	Receptor Name and Address[13]	Easting	Northing
ce	Grouped Receptor	285465	193427
cf	Grouped Receptor	285507	193520
cg	Grouped Receptor	285506	193607
ch	Grouped Receptor	285416	193612
ci	Grouped Receptor	285512	193696
cj	Grouped Receptor	285549	193895
ck	Grouped Receptor	285676	194104
cl	Grouped Receptor	285744	194128
cm	Grouped Receptor	286110	194473
cn	Grouped Receptor	286162	191380
co	Grouped Receptor	287177	189031
cp	Grouped Receptor	287202	188980
cq	Grouped Receptor	287216	189050
cr	Grouped Receptor	290772	189233
cs	Grouped Receptor	290618	189195
ct	Grouped Receptor	290728	189328
cu	Grouped Receptor	290471	189669
cv	Grouped Receptor	290315	191164
cw	Grouped Receptor	290335	189880
cx	Grouped Receptor	290476	189787
cy	Grouped Receptor	290495	189835
cz	Grouped Receptor	290624	190354
da	Grouped Receptor	290552	190484
db	Grouped Receptor	290552	190571
dc	Grouped Receptor	290517	190569
dd	Grouped Receptor	290595	190663
de	Grouped Receptor	290521	190643
df	Grouped Receptor	290564	190688
dg	Grouped Receptor	290537	190713
dh	Grouped Receptor	290604	190784
di	Grouped Receptor	290541	190803
dj	Grouped Receptor	290585	190874
dk	Grouped Receptor	290567	190948
dl	Grouped Receptor	290526	191024
dm	Grouped Receptor	287357	189193
dn	Grouped Receptor	287365	189320

Table 14.7 Summary of shadow flicker receptors subject to potential effects

Receptors	Reason for consideration
1,138 Residential Receptors Which includes 75 receptors individually assessed and 1,063 receptors assessed in 43 groups.	Considered of high sensitivity with respect to shadow flicker.

Likely significant effects

14.7.6. The effects on shadow flicker receptors which have the potential to be significant and thus have been taken forward for detailed assessment are detailed in **Table 14.6** and shown in **Figure 14.1** to **Figure 14.5.** A summary of receptors is provided in **Table 14.7.**

14.7.7. Shadow flicker is a potential operational effect of the Proposed Development (with no effects during construction or decommissioning).

Photo Sensitive Epilepsy

14.7.8. Research has been carried out to determine whether shadow flicker from wind turbines can cause seizures in photo-sensitive epilepsy sufferers[14]**.** Sufferers are usually sensitive to flickering light at frequencies from 3 Hertz (Hz) – 30 Hz. For a typical 3-blade, 45 m rotor diameter wind turbine the maximum rotational speed will be less than 20 revolutions per minute (rpm) so the blade passing frequency is 60 rpm, or 1 Hz; this is well below the 3 Hz – 30 Hz sensitivity range.

14.7.9. The proposed turbines will operate at varying speeds, up to 15 rpm. As the turbine rotors will have three blades, each blade will pass a particular point no more than 45 times a minute, which equates to a maximum frequency of 0.75 Hz. This is much lower than the 3 Hz - 30 Hz frequency range generally thought to risk triggering photo-sensitive epilepsy. It is also noted in the DECC Report (2011) that *"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".*

14.7.10. Therefore photo-sensitive epilepsy is not considered further in this assessment.

14.8 Assessment methodology

Overview

14.8.1. The generic project-wide approach to the assessment methodology is set out in **Chapter 2: Approach to EIA**. However, whilst this has informed the approach that has used in this shadow flicker assessment, it is necessary to set out how this methodology has been

[14] Harding G, Harding P, and Wilkins A, (2008): Wind turbine, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them. (online) Available at: https://onlinelibrary.wiley.com/doi/10.1111/j.1528-1167.2008.01563.x (Accessed May 2026).

applied, and adapted as appropriate, to address the specific needs of this shadow flicker assessment.

14.8.2. The assessment approach recommended within planning guidance and recognised as industry good practice, is for the assessment of shadow flicker effects to be carried out at properties within 10 rotor diameter distance from the nearest turbine. It is considered that this approach is appropriate and proportionate based on the national guidance defined significance thresholds as discussed in the next section, of greater than 30 minutes a day or greater than 30 hours per year (worst case) at the affected receptors, that fall within the 10 rotor diameter distance. A Study Area of 1,550 m from each turbine has therefore been adopted for the shadow flicker assessment in order to include land within 10 times the maximum rotor diameter (based on a worst case 150 m rotor diameter) plus a 50 m micro siting allowance.

Receptor Selection and Grouping

14.8.3. A 10 rotor diameter buffer plus 50 m for micro siting (1,550 m) was applied to the current wind turbine layout in GIS, representing the Study Area (Site layout detailed in **Figure 1.2**). Residential receptors were identified using OS AddressBase. Residential receptors that fall within the Study Area were taken forward for assessment. Given the number of receptors within the Study Area, it was necessary to group these receptors. Where multiple receptors are present in a relatively small geographic area, these receptors were grouped. Isolated receptors have been assessed individually.

14.8.4. Each individual receptor has been assessed for shadow flicker effects. The group effects are reported in the main body of this assessment (see **Section 14.9**) for ease of reading and presentation. For grouped receptors the worst-case results are reported, e.g. the maximum annual duration and maximum daily duration for all receptors in a group. There is a risk that this overpredicts some shadow flicker effects, but full and detailed results are provided in **Appendix 14B**. It should therefore be noted that not all receptors within a group have potential to experience the worst-case results reported. In addition, variation in the start times, end times, date ranges and durations of shadow flicker effects would be expected across different receptors in a group, both in theoretical terms in the reporting and in the real world should effects be experienced.

14.8.5. For clarity, this assessment has not selected a representative receptor in a group and only assessed that receptor for effects. Instead, the worst case of all receptors in a group has been reported. Full details of all individual receptors are provided in **Appendix 14B.**

Significance evaluation methodology

14.8.6. Whilst the time and duration of shadow flicker events can be predicted accurately, the level of the effect is difficult to quantify as this would depend on the location and orientation of windows within a property, the use of the rooms affected, the level of shading and screening in the surrounding area, and how susceptible the receptor is to light flicker.

14.8.7. As confirmed by the DECC study (2011)[15], there is no standard UK or Welsh guidance relating to a limit for shadow flicker. The DECC study also reviewed international

[15] *Department of Energy and Climate Change (2010). Update of UK Shadow Flicker evidence base*

legislation relating to the assessment of shadow flicker and concluded that the area within 130 degrees either side of north from the turbine, and out to 10 rotor diameters, is considered acceptable for shadow flicker assessment. The only guidance providing additional recommendations is the Northern Irish PPS 18 (2009) guidance which recommends that for properties within 500 m of the turbines, shadow flicker should not exceed 30 hours per year or 30 minutes per day.

14.8.8. For the purpose of this assessment, once the effect of theoretical shadow flicker has been modelled, the approach to establishing the magnitude of change is based on professional judgement.

14.8.9. Significance is typically defined as a function of the sensitivity of a receptor with the magnitude of change. In this case the sensitivity of the receptor (an occupied building) is considered to be high and as such significance will be defined largely as a function of the magnitude of change. A methodology for the establishment of the magnitude of change has therefore been derived based on professional experience and is presented in **Table 14.8.** This is based on the distance of the property from the turbine location along with the number of predicted hours of shadow flicker effect.

Table 14.8 Scoring Methodology for Magnitude of Change

Change	Distance from Turbine	And/Or	Reason for consideration
High	<500 m	And	Shadow flicker predicted and ≥ 30 min/day or ≥ 30 hours/year
Medium	<500 m	And	Shadow flicker predicted and < 30 min/day and <30 hours/year
Medium	500 m – 700 m	And	Shadow flicker predicted and ≥ 30 min/day or ≥ 30 hours/year
Medium	700 m – 1,550 m	And	Shadow flicker predicted and ≥ 30 min/day or ≥ 30 hours/year
Low	500 m – 700 m	And	Shadow flicker predicted and < 30 min/day and <30 hours/year
Low	700 m – 1,550 m	And	Shadow flicker predicted and < 30 min/day and <30 hours/year
No Change	>1,550 m	And	Any duration
No Change	<1,550 m	And	No shadow flicker predicted

14.8.10. The EIA Regulations require that a final judgement is made about whether or not each effect is likely to be significant. In this assessment, effects are considered to be significant or not significant according to the matrix in **Table 14.9**. Effects are rated as being either major or moderate (significant) where the magnitude of change is high or medium, or minor or negligible (not significant) where magnitude of change is low, or no change.

Table 14.9 Summary of significance of effects

Sensitivity	Magnitude of Change			
	High	**Medium**	**Low**	**No change**
High	Major (Significant)	Moderate (Significant)	Minor (Not Significant)	Negligible (Not Significant)

14.8.11. When considering **Table 14.8** and **Table 14.9** together, the significance of effects at residential receptors can be simply stated as follows:

- **Any** shadow flicker at receptors within 500 m of a wind turbine is **significant.**
- Shadow flicker at receptors located between 500 m and 1,550 m from a wind turbine, and exceeding 30 minutes per day (on any day), **and**/**or** with a duration exceeding 30 hours per year, is assessed as being **significant.**
- Shadow flicker at receptors located between 500 m and 1,550 m of a wind turbine, and not exceeding 30 minutes per day (on any day) **and** with a duration not exceeding 30 hours per year, is assessed as **not significant.**
- Receptors at a distance exceeding 1,550 m from any wind turbine, or for receptors within 1,550 m of a turbine with no shadow flicker predicted, would be assessed as **not significant.**

Factors limiting the occurrence of shadow flicker

14.8.12. There are several additional factors that can influence the amount of shadow flicker actually experienced in reality, as opposed to the worst-case results provided by computer modelling.

14.8.13. Climatic conditions dictate that the sun is not always shining. Met Office regional data for Wales provides long term climate summaries. Historic Met Office data recorded at Cardiff Bute Park over the period 1977–1995 gives average sunshine hours for the Development Site to be 33% of total daylight hours, with average lows in mid-winter being approximately 18% and peak highs in August of 42%[16],[17]. Cloud cover during other times may obscure the sun and prevent shadow flicker occurrence. Cardiff Bute Park is approximately 31 km from the Proposed Development and is expected to be broadly representative of climatic conditions at the Development Site. While some shadows may be cast under slightly overcast conditions, no shadow at all would be cast when heavy cloud cover prevails. During calm periods, or very high winds, the wind turbine blades would not rotate and shadow flicker would not occur. Turbines would also be periodically shut down for maintenance or repair work.

14.8.14. Wind turbines automatically orientate themselves to face the prevailing wind direction. This means that the turbine rotors would not always face directly towards the occupied

[16] Sun earth tools (2026). Sunrise Sunset Calendar. Available at https://www.sunearthtools.com/solar/sunrise-sunset-calendar.php#top (Accessed June 2026).
[17] Met Office (2026). UK Climate Averages. (online) Available at: https://www.metoffice.gov.uk/pub/data/weather/uk/climate/stationdata/cardiffdata.txt. Average sunshine hours of 1500 / Total number of daylight hours 4480 = 33% (Accessed May 2026)

buildings. Under some wind conditions, the proposed turbines would face 'side-on' to properties, and in these conditions only a very small area of blade movement would be visible. These factors all serve to reduce the worst-case shadow effects reported.

14.8.15. In addition to the technical factors that may limit the occurrence of shadow flicker, the effect would only be experienced where an occupier is present in a room capable of receiving shadow flicker, at a time and date when the effect is predicted to occur, and under weather conditions that allow a shadow to be cast.

14.9 Assessment of shadow flicker effects

14.9.1. **Figure 14.6** shows a contour map representing the annual number of hours of potential shadow flicker effects on the receptors included in the assessment.

14.9.2. **Table 14.10** shows the number of days per year that each receptor could be affected by shadow flicker. It also shows the maximum number of hours per day, the mean number of hours per day and the total number of hours per year that shadow flicker could occur. The likely number of hours per year when shadow flicker could occur has been calculated using Met Office records of the number of annual sunshine hours per year in Wales. Individual results for each receptor are provided in **Appendix 14B**. Note the significance of effects is based on the worst-case results, likely hours per year based on actual sunshine hours is provided for information only.

Table 14.10 Summary of shadow flicker effects. [18]

ID[19]	Days / Year	Turbine causing shadow flicker	Distance to nearest turbine causing shadow flicker (m)	Max no. of minutes / day	Mean no. of minutes / day	Maximum hours / year	Likely hours / year[20]	Magnitude of change	Significance
a	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
b	36	5	1,450.50	24	18	11.0	4.5	Low	Minor (Not Significant)
c	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
d	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
e	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
f	59	5	1,127.10	30	19	19.2	7.5	Medium	Moderate (Significant)
g	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
h	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
i	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)

[18] For receptors where no shadow flicker is predicted, the turbines causing shadow flicker and Distance to nearest turbine causing shadow flicker columns are deliberately blank.
[19] IDs with a * indicate table entries that represent a group of receptors.
[20] Based on average sunshine hours as a percentage of daylight hours.

ID[19]	Days / Year	Turbine causing shadow flicker	Distance to nearest turbine causing shadow flicker (m)	Max no. of minutes / day	Mean no. of minutes / day	Maximum hours / year	Likely hours / year[20]	Magnitude of change	Significance
j	28	1	1,545.30	22	17	8.0	2.4	Low	Minor (Not Significant)
k	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
l	25	6	1,427.60	19	11	4.7	1.3	Low	Minor (Not Significant)
m	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
n	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
o	46	6	1,402.40	16	12	8.9	1.7	Low	Minor (Not Significant)
p	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
q	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
r	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
s	57	8	1,483.00	24	18	17.5	6.9	Low	Minor (Not Significant)
t	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
u	42	6	1,405.50	16	13	9.0	1.7	Low	Minor (Not Significant)
v	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
w	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
x	28	1	1,547.90	22	17	8.0	2.4	Low	Minor (Not Significant)
y	69	1, 3	1,384.90	24	18	21.2	5.4	Low	Minor (Not Significant)
z	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
aa	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ab	62	5	1,128.50	30	19	19.7	7.7	Medium	**Moderate (Significant)**
ac	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ad	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ae	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
af	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ag	37	3	1,549.40	23	17	10.3	4.2	Low	Minor (Not Significant)
ah	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)

ID[19]	Days / Year	Turbine causing shadow flicker	Distance to nearest turbine causing shadow flicker (m)	Max no. of minutes / day	Mean no. of minutes / day	Maximum hours / year	Likely hours / year[20]	Magnitude of change	Significance
ai	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
aj	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ak	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
al	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
am	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
an	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ao	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ap	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
aq	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ar	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
as	124	7, 8	1,180.40	31	20	42.0	16.2	Medium	**Moderate (Significant)**
at	94	7, 8	1,096.20	32	21	33.4	13.0	Medium	**Moderate (Significant)**
au	114	5, 6	1,251.60	29	22	41.5	9.3	Medium	**Moderate (Significant)**
av	37	3	1,547.50	23	17	10.3	4.2	Low	Minor (Not Significant)
aw	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ax	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ay	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
az	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ba	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
bb	48	7	1,319.80	26	21	17.0	6.3	Low	Minor (Not Significant)
bc	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
bd	46	8	1,534.70	24	19	14.4	3.2	Low	Minor (Not Significant)
be	89	6, 8	953.20	36	25	37.0	11.4	Medium	**Moderate (Significant)**
bf	89	6, 8	953.20	36	25	37.0	11.4	Medium	**Moderate (Significant)**
bg	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)

ID[19]	Days / Year	Turbine causing shadow flicker	Distance to nearest turbine causing shadow flicker (m)	Max no. of minutes / day	Mean no. of minutes / day	Maximum hours / year	Likely hours / year[20]	Magnitude of change	Significance
bh	89	6, 8	953.20	36	25	37.0	11.4	Medium	**Moderate (Significant)**
bi	89	6, 8	953.20	36	25	37.0	11.4	Medium	**Moderate (Significant)**
bj	87	1, 3	996.60	33	23	34.0	9.9	Medium	**Moderate (Significant)**
bk	69	5	1,403.00	26	21	24.6	9.3	Low	Minor (Not Significant)
bl	33	5	1,336.40	25	20	10.9	3.2	Low	Minor (Not Significant)
bm	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
bn	108	1, 3	1,256.20	28	21	38.3	8.5	Medium	**Moderate (Significant)**
bo	112	1, 3	1,274.80	27	19	36.1	8.2	Medium	**Moderate (Significant)**
bp	90	1, 3	1,314.60	26	18	26.6	6.4	Low	Minor (Not Significant)
bq	103	1, 3	1,314.80	27	17	30.0	7.0	Medium	**Moderate (Significant)**
br	107	1, 3	1,252.00	28	21	38.2	8.4	Medium	**Moderate (Significant)**
bs	50	5	819.90	37	23	19.4	7.9	Medium	**Moderate (Significant)**
bt	51	5	1,409.00	26	18	15.6	5.8	Low	Minor (Not Significant)
bu	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
bv	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
bw	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
bx*	37	3	1,431.10	24	18	10.2	4.2	Low	Minor (Not Significant)
by*	32	3	1,438.10	24	18	9.1	3.6	Low	Minor (Not Significant)
bz*	30	3	1,531.50	22	17	8.0	3.0	Low	Minor (Not Significant)
ca*	62	3, 1, 3	1,441.10	24	18	17.1	6.4	Low	Minor (Not Significant)
cb*	67	1, 3, 3	1,401.10	24	18	18.4	7.1	Low	Minor (Not Significant)
cc*	62	1, 3	1,411.90	24	18	17.8	6.5	Low	Minor (Not Significant)
cd*	62	1, 3	1,410.20	24	18	18.2	6.3	Low	Minor (Not Significant)
ce*	61	1, 3	1,414.30	24	18	18.1	5.9	Low	Minor (Not Significant)
cf*	63	1, 3	1,387.90	24	18	18.5	5.6	Low	Minor (Not Significant)

ID[19]	Days / Year	Turbine causing shadow flicker	Distance to nearest turbine causing shadow flicker (m)	Max no. of minutes / day	Mean no. of minutes / day	Maximum hours / year	Likely hours / year[20]	Magnitude of change	Significance
cg*	63	1, 3, 1	1,391.30	24	18	18.5	5.6	Low	Minor (Not Significant)
ch*	28	1	1,503.80	23	17	8.0	2.7	Low	Minor (Not Significant)
ci*	64	1, 3, 1	1,397.80	24	18	18.9	5.5	Low	Minor (Not Significant)
cj*	30	1	1,485.00	23	18	8.8	2.5	Low	Minor (Not Significant)
ck*	33	1	1,513.60	23	18	9.9	2.6	Low	Minor (Not Significant)
cl*	35	1	1,490.20	24	18	10.3	2.7	Low	Minor (Not Significant)
cm*	68	1	1,526.90	24	21	23.2	4.6	Low	Minor (Not Significant)
cn*	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
co*	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
cp*	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
cq*	47	7	1,525.80	24	18	14.3	5.7	Low	Minor (Not Significant)
cr*	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
cs*	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
ct*	28	5	1,294.90	9	7	3.0	1.1	Low	Minor (Not Significant)
cu*	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
cv*	0			0	0	0.0	0.0	No Change	Negligible (Not Significant)
cw*	58	5	891.30	34	21	19.4	7.6	Medium	**Moderate (Significant)**
cx*	61	5	1,041.70	32	21	19.8	7.8	Medium	**Moderate (Significant)**
cy*	50	5	1,054.50	33	22	18.4	7.5	Medium	**Moderate (Significant)**
cz*	34	5	1,223.30	27	19	10.8	3.3	Low	Minor (Not Significant)
da*	28	5	1,223.40	25	16	7.3	2.2	Low	Minor (Not Significant)
db*	36	5	1,261.20	27	21	12.3	3.4	Low	Minor (Not Significant)
dc*	36	5	1,213.40	28	21	12.4	3.4	Low	Minor (Not Significant)
dd*	35	5	1,300.30	26	21	12.0	3.3	Low	Minor (Not Significant)
de*	36	5	1,276.10	27	21	12.4	3.4	Low	Minor (Not Significant)

ID[19]	Days / Year	Turbine causing shadow flicker	Distance to nearest turbine causing shadow flicker (m)	Max no. of minutes / day	Mean no. of minutes / day	Maximum hours / year	Likely hours / year[20]	Magnitude of change	Significance
df*	36	5	1,298.70	27	21	12.2	3.3	Low	Minor (Not Significant)
dg*	36	5	1,305.90	26	21	12.1	3.3	Low	Minor (Not Significant)
dh*	35	5	1,406.10	25	19	10.9	2.9	Low	Minor (Not Significant)
di*	36	5	1,380.10	25	20	11.4	3.0	Low	Minor (Not Significant)
dj*	38	5	1,421.40	25	20	11.4	2.9	Low	Minor (Not Significant)
dk*	39	5	1,472.70	24	19	11.9	2.8	Low	Minor (Not Significant)
dl*	42	5	1,517.50	24	19	12.1	2.8	Low	Minor (Not Significant)
dm*	48	7	1,358.00	25	19	15.0	6.0	Low	Minor (Not Significant)
dn*	40	7	1,332.90	24	17	11.0	4.5	Low	Minor (Not Significant)

14.9.3. The approach taken to the modelling assessment is theoretical and based on the worst-case scenario in that it assumes each property is occupied, that there are windows or doors facing the wind turbines, that there are no intervening obstructions, that the sun shines throughout daylight hours, that the wind blows constantly within the operating parameters of the wind turbines and that the rotor is always orientated towards the receptor.

14.9.4. The results show that 6 of 8 proposed turbines have the potential to cause shadow flicker effects, with T2 and T4 not being predicted to cause shadow flicker, although the remaining turbines that can cause shadow flicker will not cause shadow flicker at all receptors.

14.9.5. For grouped receptors denoted by a *, the worst-case results are provided for all receptors in that group, with full details of every receptor in **Appendix 14B.**

14.9.6. Examination of the detailed results of the model found in **Appendix 14B** shows that receptor AS is modelled to receive the most shadow flicker with effects modelled to last 42 hours per year, reduced to 16 hours after accounting for local prevailing climatic conditions and spread over 124 days. Receptor BS is modelled to receive the most shadow flicker on a given day, with 37 minutes predicted.

14.9.7. If average sunshine hours are applied to the model, then all receptors are likely to experience shadow flicker for no more than 16 hours per annum.

14.9.8. Receptors assessed as having potentially moderate to major significance impacts from shadow flicker could require mitigation measures to be applied. As stated in **Section 14.6**, the Applicant is committed to installing a shadow flicker control module where required. This module can control a specific turbine (or turbines) which would be programmed to shut down on specific dates at specific times when the sun is bright enough, there is

sufficient wind to rotate the blades and the wind direction is such that nuisance shadow flicker could occur. The effects are therefore concluded as not significant once this mitigation is taken into consideration. **Table 14.11** provides a summary of the assessment of shadow flicker effects.

14.10 Assessment of cumulative (inter-project) effects

14.10.1. A cumulative effects assessment (CEA) has been undertaken for the Proposed Development which considers the combined impacts with other developments on the same single receptor or resource (inter-project effects). The detailed method followed in identifying and assessing potential cumulative effects is set out in **Section 4.9** of **Chapter 2: Approach to EIA**.

14.10.2. In accordance with the shadow flicker methodology outlined in **Section 14.4** and **Section 14.8**, shadow flicker has been assessed to a distance of 10 rotor diameters of any turbine plus 50 m for micro siting, comprising the shadow flicker study area. Applying this methodology in a cumulative context, an assessment may be required for any receptors that fall within 10 rotor diameters of both the Proposed Development and a cumulative site. The CEA has considered other wind farms in the vicinity of the Study Area and identified the following wind farms:

- Llynfi Afan (operational).
- Pen y Cymoedd (operational).
- Pant y wal (operational).
- Pant y wal extension (operational).
- Ffynnon Oer (operational).
- Cwm Risca (operational).
- Upper Ogmore (consented).
- Mynydd Fforch Dwm (consented).
- Foel Trawsnant (consented).
- Mynydd Ty talwyn (application).

14.10.3. **Figure 14.7** shows the Proposed Development and study area with the closest cumulative sites and 10 rotor diameter distance buffers, based on the expected technical specifications of the third party turbines. The only cumulative site with intersecting buffers and therefore potential for cumulative effects is Llynfi Afan operational wind farm. However, no receptors fall within 10 rotor diameters of both the Proposed Development and the identified cumulative wind farms; therefore, no cumulative effects are expected in combination with the other wind farm developments.

14.10.4. It is noted that if substantial changes to the application and consented cumulative sites, or to the Proposed Development occur then this assessment may need to be revisited.

14.11 Significance conclusions

14.11.1. A summary of the results of the shadow flicker assessment is provided in **Table 14.11.**

14.11.2. The shadow flicker assessment identified the potential for significant shadow flicker effects at 18 receptors (46 unique receptors) and non-significant effects at 100 receptors (1,092 unique receptors). As detailed in **Section 14.6**, mitigation has been identified in the form of a control system, which can be activated in the event of unacceptable shadow flicker effects arising. This system would shut down the wind turbine(s) causing the shadow flicker effect, restricting effects to less than 30 minutes per day and/or 30 hours per year at any receptor. With these measures in place, no significant effects from shadow flicker would arise as a result of the Proposed Development.

Table 14.11 Summary of significance of effects

Receptor and summary of predicted effects[21]	Sensitivity / importance / value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Shadow flicker effects on 18 receptors (46 unique receptors).	High	Moderate	Moderate (significant, and following mitigation not significant)	Although according to **Table 14.11** and **Appendix 14B**, shadow flicker effects are predicted; any shadow flicker effects during operation would be investigated and fully mitigated through a shadow flicker control module which will be pre-installed in the wind turbines. By implementing the embedded measures, no significant effects would therefore arise.
Shadow flicker effects on 49 receptors (764 unique receptors).	High	Low	Minor (not significant)	Modelling has shown that significant effects are considered unlikely (**Table 14.11** and **Appendix 14B**). Any shadow flicker effects during operation would be investigated and fully mitigated through a shadow flicker control module in turbines. No significant effects would therefore arise.
Shadow flicker effects on 51 receptors (328 unique receptors).	High	No change	Negligible (not significant)	N/A

1. The sensitivity/importance/value of a receptor is defined using the criteria set out in **Section 14.8** and is defined as high for all receptors.
2. The magnitude of change on a receptor resulting from activities relating to the development is defined using the criteria set out in **Section 14.8** and is defined as low, medium and high.
3. The significance of the environmental effects is based on the combination of the sensitivity/importance/value of a receptor and the magnitude of change and is expressed as major (significant), moderate (potentially significant) or minor/negligible (not significant), subject to the evaluation methodology outlined in **Section 14.8**