14. Other Issues

14.1 Introduction

14.1.1 This chapter assesses the potential effects of the revised Proposed Development in relation to:

- Shadow Flicker; and
- Other Telecommunications.

14.1.2 The assessments relating to Shadow Flicker, Television, Radio, Telecommunications, and Fixed Links have been undertaken by SLR Consulting.

14.2 Shadow Flicker and Reflected Light

Introduction

14.2.1 In sunny conditions, any shadow cast by a wind turbine will mirror the movement of the rotor. When the sun is high, any shadows will be confined to the Proposed Development area but when the sun sinks to a lower azimuth moving shadows can be cast further afield and potentially over nearby properties. Shadow flicker is generally not a disturbance in the open as light outdoors is reflected from all directions. The possibility of disturbance is greater for occupants of buildings when the moving shadow is cast over an open door or window, since the light source is more directional.

14.2.2 Whether shadow flicker is a disturbance depends upon the observer's distance from the turbine, the direction of the dwelling and the orientation of its windows and doors from the Proposed Development, the frequency of the flicker and the duration of the effect, either on any one occasion or averaged over a year.

14.2.3 In any event and irrespective of distance from the turbines, the flickering frequency will depend upon the rate of rotation and the number of blades. It has been recommended (Clarke, 1991) that the critical frequency should not be above 2.5 Hz, which for a three-bladed turbine is equivalent to a rotational speed of 50 rpm (revolutions per minute). While the rotation speed of the turbines will be dynamic, it is expected that the turbines at the Proposed Development would rotate at a maximum speed of approximately 15 rpm, well below this threshold.

Policy and Guidance

14.2.4 This assessment has taken into consideration the policies contained in the National Planning Framework 4 (NPF4) (Scottish Government, 2023), and East Ayrshire Local Development Plan 2 (2024) (EALDP2).

14.2.5 Particularly, Policy 11 part (e)i. of NPF4 (2023) states that any potential impacts on communities from shadow flicker must be addressed by the development. This is further noted within EALDP2 policy RE1: Renewable Energy.

14.2.6 The update to Shadow Flicker Evidence Base, published by the then Department

for Energy and Climate Change (DECC), states that assessing shadow flicker effects within ten times the rotor diameter of wind turbines and a range of 130 degrees either side of north has been widely accepted across different European countries, and is deemed to be an appropriate area.

Consultation

14.2.7 The intention to undertake shadow flicker assessment was outlined within the EIA Scoping Report in June 2024. East Ayrshire Council (EAC) responded that '*there is no level of shadow flicker which is deemed to be acceptable set out in guidance within the country, and all shadow flicker will require to be mitigated, not just anything in excess of 30 hours per year or more than 30 minutes per day. As such a significant effect would be any shadow flicker.*'

14.2.8 No other comments relating to shadow flicker were received from consultees in the EIA Scoping Opinion.

14.2.9 No responses were received relating to shadow flicker during the Scottish Ministers' consultation on the May 2025 Application.

Guidance

14.2.10 The update of UK Shadow Flicker Evidence Base (DECC, 2011) reviews international legislation relating to the assessment of shadow flicker for wind turbine development and concludes 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 DECC study also concluded that there have not been extensive issues with shadow flicker in the UK and, in circumstances where the potential for significant shadow flicker issues effects have been identified, these have been resolved using standard mitigation.

14.2.11 This assessment also takes into consideration the Scottish Government Online Renewables Planning Advice: Onshore Wind Turbines (Scottish Government, 2014) which states "*where separation is provided between wind turbines and nearby dwellings (as a general rule, 10 rotor diameters), 'shadow flicker' should not be a problem*".

Assessment Methodology

14.2.12 Analysis was performed on all properties within ten rotor diameters of any turbine.

14.2.13 This shadow flicker assessment is based on wind turbines with a 136 m rotor diameter. This means using 10 rotor diameters within 130 degrees either side of north from the turbine, the Study Area extends to 1.36 kilometres (km) from each turbine.

14.2.14 Analysis was then undertaken for shadow flicker at all properties within 1.36 km from any wind turbine.

14.2.15 This analysis takes into account the motion of the Earth around the Sun, the local topography and the turbine locations and dimensions. The analysis was performed

using the revised Proposed Layout, a layout of up to 20 turbines, each with maximum tip height of 149.9 m.

Shadow Flicker Modelling

14.2.16 The commercial software model WindPro 4.1 was used to calculate the expected number of hours shadow flicker that could occur at each receptor. The model takes into account the movement of the sun relative to the time of day and time of year and predicts the time and duration of expected shadow flicker at a window of an affected receptor. The input parameters used in the model are as follows:

- the turbine locations;
- the turbine dimensions;
- the location of the receptors to be assessed; and
- the size of windows on each receptor and the direction that the windows face.

14.2.17 The WindPro model is based upon a Zone of Theoretical Visibility (ZTV) analysis, which in this case was based upon a Digital Terrain Model (DTM) of 5 m resolution.

14.2.18 The model was run for both a worst-case scenario (accounting for 365 sunshine days per year and 100% turbine operation) and realistic scenario (using, where possible, measured meteorological data and 85% turbine operation) on the potential shadow flicker occurrence for a 1 m x 1 m ground floor window at each identified sensitive receptor location, assumed to be facing directly towards the Proposed Development.

Assessment of Significance of Potential Effects

14.2.19 Within this assessment, the sensitivity of the receptors was assumed to be high in all cases as all receptors are residential dwellings. As stated previously, EAC stated that any shadow flicker effect should be treated as a significant effect and be mitigated as such.

Assessment Scenarios

Worst-Case Scenario

14.2.20 Calculations were undertaken for predicted shadow hours at each of the receptors for two scenarios: a theoretical (worst-case) and a realistic scenario. For the worst-case scenario the following assumptions were made:

- all receptors have a 1 m x 1 m window facing directly towards the turbine;
- the turbine blades were assumed to be rotating for 365 days per year;
- there is a clear sky 365 days per year;
- the turbine blades were assumed to always be positioned towards each receptor;
- more than 20 % of the sun is covered by the blade; (in practice, at a distance, the blades do not cover the sun but only partly mask it, substantially weakening

the shadow);

- the receptor is occupied at all times; and
- no screening is present.

14.2.21 The effect of shadow flicker was not calculated where the sun lies less than three degrees above the horizon due to atmospheric diffusion, low radiation (intensity of the sun's rays is reduced) and high probability of natural screening. It is generally accepted that below three degrees shadow flicker is unlikely to occur to any significant extent (Nordhein-Westfalen, 2002).

14.2.22 These assumptions result in a highly conservative assessment for the following reasons:

- the receptor may not directly face the turbines;
- the turbine blades will not turn for 365 days of the year, and will turn to face into the direction of the wind, in order to maximise the energy generating potential from the wind, and therefore will not always face the receptor;
- it is unlikely that there will be clear skies 365 days a year;
- the receptor may not be occupied at the time that the shadow flicker impact is experienced; and
- screening, such as vegetation including the surrounding forestry, or curtains/blinds between the window and the turbine, is not accounted for within the model and, in practice, such screening will prevent any shadows from being cast onto the window and therefore prevent any flickering effect.

14.2.23 In addition, the distance between the turbine and a window has an impact on the intensity of any shadow flicker that is experienced. The study area has been set at 10 rotor diameters as the effects of shadow flicker are shown to be greatly reduced outside this distance.

14.2.24 The assessment carried out is limited to the effects of shadows within buildings. Moving shadows will also be apparent out of doors; however, these do not result in flicker in the same manner or to the same extent, as the light entering windows. Therefore, shadow flicker effects outdoors have been scoped out of further assessment.

14.2.25 The modelling results for the theoretical scenario are typically considered to be a theoretical worst-case estimation of the actual impacts experienced, which would not arise in practice given the assumptions listed above.

Realistic Scenario

14.2.26 For much of the year weather conditions will be such that shadows will not be cast or will be weak and would therefore not give rise to shadow flicker effects. WindPro calculations most likely overestimate the duration of effects as outlined in the theoretical scenario. Other factors such as the potential for screening by vegetation or structures will also reduce or prevent flicker incidence in practice. To create a

more realistic scenario for the potential impact of shadow flicker on receptors, it was necessary to identify the expected meteorological conditions at the site and take into account any significant shielding of receptors by buildings and vegetation between the receptor and the turbines.

14.2.27 In order to estimate the impact of cloud cover, information available from the Met Office (2024) was used to consider the likelihood of sunshine at different times of the year, and therefore allow calculations of the 'expected' values for shadow flicker occurrence. As part of the WindPro calculation it is possible to upload data from a nearby climatic station to the Proposed Development. In the case of the Proposed Development this is Girvan weather station. Girvan was selected as it was the nearest weather station to the Proposed Development that had long-term data for both sunshine hours and wind.

14.2.28 The realistic scenario represents a long-term average as it is based on long-term historic metrological data. The variation between individual years can be significant and may lead to future observations differing from the predicted results.

14.2.29 A 16-degree sector wind rose was calculated for 7,446 hours of wind (assuming the Proposed Development is operational for 85 % of the year) based on RenSMART data. The data was from New Cumnock weather station over the period 2000-2010, as no meteorological mast data was available at the site for a long-term period.

14.2.30 The WindPro model also employs a slightly simplistic assumption that sunshine probability and turbine operational probability are independent parameters. The model is therefore expected to yield slighting higher results, as there is a degree of correlation between bright and sunny weather conditions and low wind speeds.

14.2.31 There are a number of assumptions which remain in the realistic scenario model which lead to the model still predicting higher levels of shadow flicker than are likely to be experienced. These assumptions are;

- all receptors have a 1 m x 1 m window facing directly towards the turbine;
- the receptor is occupied at all times; and
- no screening is present.

Limitations to Assessment

14.2.32 All assumptions made by the WindPro 4.1 model are noted above.

14.2.33 Given the absence of UK guidance on shadow flicker, the assessment has adopted the generally accepted industry practice of hours per year or minutes per day on the worst affected day, whichever is the greatest for permanent dwellings within 10 rotor diameters of the proposed turbines to display the data.

14.2.34 The realistic scenario results represent an average as they are based on historic meteorological data from Girvan and New Cumnock weather stations. The variation between individual years can be significant and may lead to future observations differing from the predicted results.

14.2.35 As noted above, the historic meteorological data was also taken from Girvan and New Cumnock weather station and is not site-specific so there may be slight variations in the historical data used.

Baseline Conditions

14.2.36 Three receptors have been identified within the Study Area with the potential to experience shadow flicker (refer to **Figure 14.1** and **Tables 14.1** and **14.2**).

14.2.37 For the purpose of the assessment, it is assumed that the properties face the Proposed Development and no local screening (vegetation and blinds/curtains) are considered.

14.2.38 Within this assessment the sensitivity of receptors is assumed to be high in all cases.

Potential Effects

14.2.39 **Figure 14.1** details the locations of affected properties relative to the Proposed Development.

14.2.40 With due reference to the DECC report, the potential shadow flicker is given in **Table 14.1** and **Table 14.2**. **Table 14.1** represents the theoretical worst-case scenario discussed in the previous section. **Table 14.2** represents the realistic case.

Table 14.1: Shadow Flicker Assessment Summary of Results – Worst Case

Property ID	Property Address	Total hours per year	Change from hours per year reported in the May 2025 Application	Shadow Flicker Minutes on Worst Day	Change from minutes on Worst Day reported in the May 2025 Application
A	Drumbowie Farm, Rankinston, East Ayrshire	22:14	Increase of 7 hours per year.	44	Increase of 13 minutes on the Worst Day.
B	Ravenscroft Farm, Rankinston, East Ayrshire	32:58	Decrease of 0.5 hours per year.	25	Same (25).
C	Rankinston Farm, Rankinston, East Ayrshire	51:11	Decrease of 6 hours per year.	28	Increase of 1 minute on the Worst Day.

Table 14.2: Shadow Flicker Assessment Summary of Results – Realistic Case

Property ID	Property Address	Total hours per year	Change from hours per year reported in the May 2025 Application	Shadow Flicker Minutes on Worst Day	Change from minutes on Worst Day reported in the May 2025 Application
A	Drumbowie Farm, Rankinston, East Ayrshire	2:04	Increase of 0.5 hours per year.	5.28	Increase of 2 minutes 17 seconds on the Worst Day.
B	Ravenscroft Farm, Rankinston, East Ayrshire	4:59	Increase of four 4 minutes per year.	4.8	Increase of 1 minute on Worst Day
C	Rankinston Farm, Rankinston, East Ayrshire	7:49	Decrease of 34 minutes per year.	5.32	Increase of 2.4 minutes on Worst Day.

14.2.41 The model still does not take into consideration any local screening from vegetation, blinds or curtains, or true window orientation relative to the turbines, which in reality will further reduce the potential time receptors are likely to experience shadow flicker over the course of the year. This model also still assumes that all receptor windows face towards the wind turbines and that receptors are occupied at all times of the day that shadow flicker is predicted.

14.2.42 The realistic scenario model does indicate potential for shadow flicker to occur for at least short periods at all three receptors.

14.2.43 Analysis of the worst-case modelling data in **Table 14.1** reveals that the shadow flicker hours per year has increased at Drumbowie, but decreased at Ravenscroft and Rankinston Farm. The only predicted impact which is above the significance threshold is the 44 minutes of shadow flicker predicted for the worst-day at Drumbowie Farm. However, the predictions provided by the worst-case modelling are unrealistic for the reasons discussed earlier in the chapter.

14.2.44 The realistic case scenarios in **Table 14.2** are much lower than worst-case, and will also be well within the significance thresholds of 30 hours per year and 30 minutes per day.

14.2.45 While the number of realistic-case shadow flicker hours per year calculated for Drumbowie has increased by 0.5 hours per year since the May 2025 Application to just over 2 hours, the total hours per year of shadow flicker is still well below the significance threshold of 30 hours per year. Similarly, although the number of minutes on the worst day has increased by just over 2 minutes to 5.28 minutes, this is still well below the significance threshold of 30 minutes per day.

14.2.46 Realistic-case modelling shows that the number of hours per year that could be experienced at Ravenscroft Farm has increased by only 4 minutes to just less than 5 hours while the number of minutes on the worst day has increased by 1 minute to 4.8 minutes – both well below the respective significance thresholds.

14.2.47 For Rankinston Farm, the predicted number of hours per year has reduced by 34 minutes to less than 8 hours and the number of minutes on the worst day has increased by 2.4 minutes to 5.32 minutes – with both totals again being well below the respective significance thresholds.

14.2.48 However, as requested by EAC, any impact on receptors is considered S*ignificant* and will need to be mitigated as a result.

14.2.49 It is important to stress the theoretical and conservative nature of the model, and the absence of any consideration of screening in the model. For these reasons it is unlikely the number of hours predicted in the 'realistic' scenario would actually occur at the sensitive receptors. In reality, the expected total shadow hours will be less than modelled. Notwithstanding these points and the financial involvement of two receptors (Rankinston and Ravenscroft), the Applicant is committed to provide a Shadow Flicker Mitigation Protocol to be activated, should any concerns in relation to shadow flicker effects be raised, or shadow flicker subsequently be found to be causing nuisance in certain atmospheric conditions.

Cumulative Impacts

14.2.50 In order to assess the potential for cumulative impact from other wind developments in the surrounding area, any turbines within 5 km of the Proposed Development turbine locations were reviewed.

14.2.51 As shown on **Figure 14.3**, no cumulative study areas overlap with the potential shadow flicker receptors meaning there would be no significant impact from current cumulative developments (including those that are operational, under construction and in planning) in the area.

Mitigation

14.2.52 Although the realistic scenario takes into consideration expected operational time for the turbines and average sunshine hours for the region, the results are likely to still be conservative due to local vegetation, dwelling orientation and internal screening from blinds, curtains or furniture that are not included in the model. Additionally, while shadow flicker may potentially occur at these locations it is possible that flicker will not be 'experienced' at all locations due to the time of day during which it may potentially occur and use of the properties.

14.2.53 Nevertheless, in the event of consent being granted, in order to ensure that potential shadow flicker effects do not exceed acceptable limits at any property, the Applicant proposes that prior to the erection of the first turbine a written scheme (known as the 'Wind Farm Shadow Flicker Protocol') will be submitted to and approved in writing by the Local Planning Authority. This will set out mitigation measures to alleviate shadow flicker attributable to the Proposed Development as well as a protocol for addressing a complaint received from a receptor within the Study Area.

14.2.54 Operation of the turbines would be required to take place in accordance with the approved Shadow Flicker Protocol and any mitigation measures that have been agreed through the protocol would require to be implemented as appropriate.

14.2.55 Mitigation measures could include the provision of local screening to reduce or block shadow flicker affecting a receptor. Should screening provision not be possible, the most effective mitigation measure to mitigate shadow flicker is by selective automatic turbine shutdown during the times of year when shadow flicker is predicted, if the weather conditions are correct. The relevant technology which will allow for the automatic shutdown of the turbine will be fitted to the Proposed Development turbines and details included within the 'Wind Farm Shadow Flicker Protocol'.

14.2.56 As stated above, no cumulative effects are expected therefore no further mitigation measures are required.

14.2.57 It is proposed that the provision and agreement of a Wind Farm Shadow Flicker Protocol is secured through a condition attached to the permission.

14.3 Television, Radio, Telecommunications and Fixed Links

Introduction

This section of the chapter summarises the potential effects of the Proposed Development on television, radio, telecommunications and fixed links.

Legislation, Policy and Guidance

- Wireless Telegraphy Act (UK Government, 2006);
- East Ayrshire Local Development Plan - Supplementary Guidance: Planning for Wind Energy (East Ayrshire Council, 2017);
- Planning Advice Note: PAN 62 Radio Telecommunications (Scottish Government, 2001b); and
- Tall structures and their impact on broadcast and other wireless services (Ofcom, 2009).

Scope of Assessment

14.3.1 In order to determine whether the construction, operation and decommissioning of the Proposed Development would have any effects (whether significant or not) on telecommunications, television and radio infrastructure and networks in the area, the baseline of existing infrastructure was established using publicly available information. However, given that not all fixed links are published, individual consultations with system operators was also undertaken to establish whether there was any the potential for the Proposed Development to cause electromagnetic interference.

Current Baseline

14.3.2 Potential telecommunications constraints were identified using publicly available information. Ofcom, responsible for licensing two-way radio transmitters, maintains a register of most fixed links and were consulted to establish baseline conditions.

14.3.3 The telecommunications fixed links present within 5 km of the Site (based on publicly available data) are shown on **Figure 14.3**.

14.3.4 However, not all telecommunications links and frequencies are published. Consequently, telecommunications and broadcasting network operators were consulted both for the May 2025 Application layout and again for the Additional Information: Revised EIA layout to determine whether any broadcasting or telecommunications infrastructure was present within or near the Site. The following telecommunications operators confirmed in November 2025 that they have no concerns relating to the revised Proposed Development:

- BT;
- JRC;
- Atkins;
- Telefonica;
- Mobile Broadband Network Limited; and
- Ofcom/Vodafone.

Potential Effects

Television and Broadcast Radio

14.3.5 Digital television signals, being more adept at handling signal reflections than analogue signals, do not experience ghosting (Ofcom, 2009). Considering the robust nature of digital television reception in the area and the strength of the digital signal, the risk of interference with domestic television reception due to a wind energy development at this location is deemed low.

14.3.6 Broadcast radio (FM, AM, and DAB digital radio) transmits on lower frequencies compared to terrestrial television signals. Lower frequency signals generally navigate obstructions more easily, and diffraction effects are more pronounced at lower frequencies, both factors mitigating the impact of new structures on broadcast radio (Ofcom, 2009).

14.3.7 Since digital television is less likely to be affected by the atmospheric conditions that rendered analogue television unwatchable and does not suffer from reflection effects or ghosted image generation, it is very unlikely that digital television will be affected by the Proposed Development, and potential effects have therefore not been further assessed.

14.3.8 Assessment of effects on broadcast radio have also not been assessed due to the low likelihood of interference with and diffraction of radio signals by the Proposed Development turbines.

Microwave Fixed Links and Scanning Telemetry

14.3.9 Based on the available information, and on consultation responses from telecommunications operators and other key consultees (e.g. JRC and BT), there are no telecommunications fixed links or scanning telemetry links within or near the

Site. It can therefore be concluded that there will be no effects on telecommunications resulting from the operation of the Proposed Development.

Conclusion

14.3.10 Based on both publicly available information and correspondence with key consultees and telecommunications operators, it can be concluded that the revised Proposed Development will not affect any existing telecommunications links.

14.4 References

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