Environmental Impact Assessment Report

Teindland Wind Farm

Volume 1

Chapter 15: Other Issues

Document prepared by Envams Ltd for: Teindland Wind Farm Ltd

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Contents

15 OTHER ISSUES

The shadow flicker assessment (section 15.1) was undertaken by Alan Moore, one of the directors of Metrica Ltd, specialist noise, shadow flicker, vibration, air quality and glint and glare consultants. Alan has over 14 years of experience of the assessment of shadow flicker from wind farms. Alan is a member of the Institute of Environmental Management and Assessment (AIEMA).

Other aspects of this chapter have been undertaken by Paul Phillips, one of the directors of Envams Ltd, an environmental and planning consultancy specialising in renewable energy development in the UK. Paul is an IEMA Registered Environmental Impact Assessment Practitioner with over 20 years experience in Environmental Impact Assessment, the large majority of which he has spent working on renewable energy developments.

15.1 SHADOW FLICKER

15.1.1 Introduction

This section of the EIAR evaluates the effects of shadow flicker on nearby receptors from the proposed Teindland Wind Farm (the Development) on land owned by Forestry and Land Scotland approximately 3 km north of Rothes, Moray, (the Site).

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. Shadow flicker is an effect that can occur when the shadow of a blade passes over a small opening (such as a window), briefly reducing the intensity of light within the room, and causing a flickering to be perceived. Shadow flicker effects only occur inside buildings where the blade casts a shadow across an entire window opening.

The likelihood and duration of the effects depends on a range of factors including the direction, distance and aspect of residential dwellings in relation to the turbines, turbine height and rotor diameter, the topography between residential dwellings and turbines, the time of year and day, and local weather conditions.

This section refers to the following figure in Volume 2a of this EIAR:

- Figure 15.1: Shadow flicker study area.

15.1.2 Legislation, Policy and Guidance

The following guidance and information sources have been considered in carrying out the shadow flicker assessment:

- Onshore Wind Turbines: Planning Advice[1]; and
- Review of Light and Shadow Effects from Wind Turbines in Scotland[2].

15.1.2.1 Online Planning Guidance for Onshore Wind Turbines

The Scottish Government's 2014 Online Planning Guidance is the most current guidance available in terms of shadow flicker and has been used to inform the methodology for this assessment. It 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."*

15.1.2.2 Review of Light and Shadow Flicker Effects from Wind Turbines in Scotland

A review of light and shadow effects from wind turbines was commissioned by ClimateXChange in March 2017. It looked at how light and shadow flicker effects are

[1] Scottish Government (2014) Onshore Wind Turbines: planning advice. [Online] Available at: https://beta.gov.scot/publications/onshore-wind-turbines-planning-advice/ (Accessed on 27/01/2025)

[2] LUC (2017) Review of Light and Shadow Flicker Effects from Wind Turbines in Scotland. [Online] Available at: https://www.climatexchange.org.uk/projects/review-of-light-and-shadow-effects-from-wind-turbines-in-scotland/ (Accessed on 27/01/2025)

considered in the development planning process in Scotland. The review also considered current UK guidance and how it is applied through case studies.

It should be noted that since the publication of the review (2017), shadow flicker guidance in Scotland has not changed, and as such, the existing guidance set out in Onshore Wind Turbines: Planning Advice remains extant.

15.1.3 Assessment Methodology and Significance Criteria

Shadow flicker is a phenomenon that only occurs once the turbines are installed and operational and thus no shadow flicker effects are anticipated during the construction or decommissioning phases of the Development. As such, the construction and decommissioning phases have been scoped out of the assessment.

15.1.3.1 Study Area

The residential dwellings with potential to be affected by shadow flicker as a result of the Development were identified using Ordnance Survey (OS) mapping, aerial imagery and Geographical Information System (GIS) software.

The intensity of shadows decrease as the distance to the turbines increases: the Scottish Government's 2014 Online Guidance refers to ten rotor diameters as the distance beyond which shadow flicker should not be a problem. Shadow flicker effects can theoretically occur at distances greater than ten rotor diameters from turbines, albeit reduced in intensity. However, any effects upon properties outwith the ten rotor diameter distance are unlikely to be significant and therefore have not been considered further.

The ten rotor diameter Study Area was mapped for each turbine of the Development. Based upon a likely worst case rotor diameter of 173 metres (m), the Study Area is a distance of 1,730 m from each of the proposed turbines as shown in Figure 15.1.

15.1.3.2 Identification of Receptors

Potential sensitive receptors within the Study Area were identified using Ordnance Survey (OS) AddressBase data; (a database which combines Royal Mail address data with buildings identified on large-scale OS mapping and provides addresses, descriptions and grid references). The receptors identified using AddressBase data were verified against OS 1:25,000 scale digital mapping, online aerial imagery and through liaison with the Applicant.

A total of 32 residential dwellings were identified as potential receptors within the Study Area as shown in Figure 15.1.

The assessment of shadow flicker is a desk-based assessment, and as such, no on-site survey specific to shadow flicker has been undertaken.

15.1.3.3 Methodology for the Assessment of Effects

A recognised computer software package[3] was used to calculate theoretical specific times and durations of shadow flicker effects at identified potential receptors.

This software creates a mathematical model of the Development and its surroundings, based on:

- Turbine locations;
- Turbine dimensions (hub height of 143.5 m except T2, T5 and T7 which are 114 m and a rotor diameter of 173 m for all turbines);
- Topography (OS Terain50); and
- Latitude and longitude of the Site (used in calculating the position of the sun in relation to time of day and year).

Certain worst-case assumptions are made in the calculation, namely:

- Weather conditions during all times when shadow flicker could occur are such that strong shadows would be cast (i.e. clear skies and bright sunshine);
- The wind direction at all times when shadow flicker could occur is such that turbine rotors will always be facing directly towards the receptors, maximising the size of the shadow and hence the frequency and duration of the effect;

[3] Resoft WindFarm 5.1.1.4

- The wind speed at all times when shadow flicker could occur is sufficient for the turbine rotors to turn; and
- Calculations are made on a 'bare earth' basis, with line of sight interrupted only by topography; intervening structures or vegetation that may provide screening to the receptors are not accounted for.

The following best practice assumptions have been made for all potential receptors in order to identify all potential effects:

- All windows have been assumed to measure 1 m by 1 m (for larger windows the intensity of the effect would be reduced), to be situated at a height of 3 m above ground level to the window's centre (representing an average of ground and first floor levels that may be typically at a height of 1.5 m and 4.5 m, respectively);
- Windows facing towards each of the cardinal compass point directions (north, south, east and west) have been modelled in order to identify effects from all possible directions. In practice, not all of these directions face the Development, and the buildings may not have windows on each façade;

The above calculations are intended to indicate a theoretical maximum potential duration of effects and to provide an approximation of the times of day and year that these would occur.

For much of a given year, weather conditions will be such that shadows would not be cast, or would be weak and thus would not give rise to shadow flicker effects. In Keith, Aberdeenshire (the closest Met Office long term weather station to the Development), cloud cover occurred for 65% of the time, resulting in bright sunshine occurring for around 35% of daylight hours from January 2024 to December 2024.

In practice, other factors will also reduce or prevent flicker incidence even further as compared to the theoretical maximum period or the likely period of effect suggested by the calculations, including:

- The potential for screening by vegetation or intervening structures;
- Whether the wind is blowing in order to make the turbine blades move at all; and
- The varying orientation of the turbines due to varying wind direction causing the angle of the moving shadow to be reduced.

These factors are not accounted for in the calculations and as such durations of shadow flicker presented in this assessment are an over-estimation of actual effects likely to be experienced in practice. The computer model is therefore considered to overestimate the duration of effects by approximately three times.

15.1.3.4 Significance of Effect

No formal guidance is available regarding what levels of shadow flicker may be considered acceptable in the UK. However, Wind Energy Development Guidelines5 (WEDG) published by the Northern Ireland Department of the Environment, Heritage and Local Government (2006) states that:

> *"It is recommended that shadow flicker at neighbouring offices and dwellings within 500 m should not exceed 30 hours per year or 30 minutes per day."*

This assessment predicts the theoretical maximum effects, along with a likely maximum duration for effects once prevailing weather conditions are taken into account. Although the WEDG states that the threshold (i.e. 30 hours per year or 30 minutes per day) should apply to neighbouring offices and dwellings within 500 m of a wind turbine, all receptors within 10 rotor diameters of the Development have been considered as a conservative approach.

15.1.4 Baseline Conditions

Table 15.1 below provides details of the identified properties, as shown in Figure 15.1.

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[4] W5orld Weather Online [Online]. Available at: https://www.worldweatheronline.com/keith-inch-weather-averages/aberdeenshire/gb.aspx [Accessed 27/01/2025]

[5] Department of the Environment, Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy', 2009

Table 15.1 Shadow Flicker Assessment Locations

Receptor ID	Property Name	Easting	Northing	Nearest Turbine	Distance to Nearest Turbine (m)
1	Cairnty View	330558	855304	5	1585
2	Crofts Cottage	328659	850615	7	1592
3	Barluack Farmhouse	326864	852579	13	1234
4	Hillfolds Cottage	326904	852594	13	1190
5	Auchinroath House	326908	851418	7	1628
6	Maryhill	330234	854515	2	1312
7	Sauchenbush Caravan	327332	851728	7	1114
8	Teindland Wells	328149	856328	5	1261
9	Imladris	330439	855429	5	1470
10	2Upper Inchberry Cottage	330637	855096	5	1686
11	Burnside House	327458	855694	3	1372
12	1 Upper Inchberry Cottage	330635	855088	5	1686
13	Broomfield	330616	855368	5	1646
14	Smallburn House	327384	851558	7	1148
15	Fir Tree Cottage	326824	851454	7	1689
16	Sunnybraes	330527	855493	5	1557
17	Sauchenbush	327335	851772	7	1093
18	Braes	330383	855732	5	1460
19	Aultonside Farm	329296	857066	5	1720
20	Teindland Mains	328022	856168	5	1240
21	Mains of Teindland Cottage	328047	856167	5	1221
22	Crofts Farm	328535	850651	7	1541
23	Carraburn	329966	854763	2	1647
24	Maryhill Cottage	330617	854550	7	1697
25	Newlands Cottage of Dundurcas	329734	851195	7	1703
26	Glen of Rothes - The Cottage	326734	851635	7	1706
27	Burnside of Whiteriggs	330396	854245	11	1289
28	Nether Sauchenbush	327068	851323	7	1541
29	Glen of Rothes	326726	851606	7	1722
30	Woodside Croft	330304	856385	5	1670
31	Sourden House	329579	850981	7	1715
32	Rose Cottage	331200	852813	11	1683

15.1.4.1 *Assessment Limitations*

The assessment is based upon a number of worst-case assumptions, including no intervening vegetation or structures between the receptors and the turbines, the turbine rotors are always facing directly towards a given window, and the turbines will always be rotating.

In practice it is anticipated that impacts will be substantially lower than those assessed in this report. As such, no substantial assessment limitations exist.

15.1.5 Assessment of Potential Effects

Table 15.2 details the results of the calculations carried out at the assessment locations identified using the shadow flicker modelling software. The table presents the likely number of days per year during which shadow flicker may occur, the maximum length of occurrence in any one day, the theoretical maximum hours of shadow flicker per annum, and the 'likely' number of hours per year (taking into account average annual sunshine hours)[6].

Table 15.2 Potential Shadow Flicker Effects at the Assessed Location

Receptor ID	Name	Maximum Minutes per Day	Theoretical Maximum Hours per Annum	Likely Hours per Annum
1	Cairnty View	27	13	5
2	Crofts Cottage	0	0	0
3	Barluack Farmhouse	37	82	29
4	Hillfolds Cottage	38	86	30
5	Auchinroath House	28	22	8
6	Maryhill	32	94	33
7	Sauchenbush Caravan	51	57	20
8	Teindland Wells	35	39	14
9	Imladris	29	15	5
10	2Upper Inchberry Cottage	26	12	4
11	Burnside House	34	62	22
12	1 Upper Inchberry Cottage	26	12	4
13	Broomfield	26	12	4
14	Smallburn House	15	6	2
15	Fir Tree Cottage	28	27	9
16	Sunnybraes	28	13	5
17	Sauchenbush	51	64	23
18	Braes	29	14	5
19	Aultonside Farm	20	8	3
20	Teindland Mains	35	45	16
21	Mains of Teindland Cottage	36	45	16
22	Crofts Farm	0	0	0
23	Carraburn	44	118	41
24	Maryhill Cottage	27	28	10
25	Newlands Cottage of Dundurcas	0	0	0
26	Glen of Rothes - The Cottage	26	15	5
27	Burnside of Whiteriggs	34	41	14
28	Nether Sauchenbush	16	7	2
29	Glen of Rothes	26	16	5
30	Woodside Croft	26	14	5
31	Sourden House	0	0	0
32	Rose Cottage	0	0	0

[6] Based on bright sunshine occurring for around 35% of daylight hours.

Without suitable mitigation of the 32 potential receptors identified within the study area, a total of 11 properties are anticipated to experience shadow flicker effects for more than 30 minutes per day or 30 hours per year.

15.1.6 Mitigation

Where shadow flicker effects are likely to exceed the threshold of 30 minutes per day and 30 hours per year, mitigation is necessary. Several forms of mitigation for shadow flicker are available, including;

- Control at Receptor: The provision of blinds, shutters or curtains to affected properties, or moving windows;
- Control on Pathway: for example, screening planting or fencing close to an affected property; and
- Control at Source: for example, shutdown of turbines at times when effects occur.

Control at receptor and control on pathway mitigation measures can be effective, but can be limited in effectiveness (as they may mask rather than remove the effects), and can take time to become effective (as in the case of screening through planting).

Control at source is the most effective method for mitigating shadow flicker effects. This involves shutting turbines down at times when shadow flicker is likely to occur; the times are pre-calculated and programmed into the 'shutdown calendar' of the Development's SCADA system (Supervisory Control and Data Acquisition system which is the central computerised monitoring system), although this does not take account of weather conditions occurring at specific times, resulting in excessive shutdowns. Photocells can be installed that determine whether ambient light levels are sufficient for distinct shadows (and therefore shadow flicker) to be generated to prevent unnecessary shutdowns.

Alternatively, a shadow flicker protection system can be incorporated into the SCADA system. This calculates the locations of shadows in real time, determines whether these coincide with the pre-programmed locations and takes into account ambient lighting before triggering shutdowns. These systems provide greater flexibility than shutdown calendars as it allows for new receptor locations to be programmed, for example if complaints are received from a property not already included in an existing mitigation scheme.

Any shadow flicker complaints will be investigated and, if shadow flicker is occurring, mitigation measures will be discussed with the residents. If necessary, shadow flicker will be controlled at source using one of the systems outlined above, in order to ensure that the operation of the Development does not result in shadow flicker occurring for more than 30 minutes per day or 30 hours per year at any property.

Shadow flicker effects are typically controlled through the use of a planning condition to ensure a scheme detailing the protocol for the assessment of any complaints of shadow flicker resulting from the development on residential properties existing at the date of the grant of planning permission, including remedial measures, is prepared prior to the start of operation and then implemented.

Application of the above measures will ensure that effects are reduced to acceptable levels or removed entirely.

15.1.7 Cumulative Effect Assessment

No other wind farms either operational, consented or subject to a validated planning application have been identified at a distance where the shadow flicker study area would overlap with that of the Development. As such, there can be no cumulative shadow flicker effects in combination with the Development.

It is of note that Blackhills Wind Farm is currently at the Scoping stage, located immediately to the west of the Development. Given the early stage in the development's design, the turbine layout for that project has not been confirmed and as such, there are no turbine locations that can be used to determine the presence of any cumulative effects. Should Blackhills Wind Farm progress to the EIA stage, it is anticipated that the associated EIAR will consider any cumulative effects in combination with the Development.

15.1.8 Residual Effects

With appropriate mitigation applied, residual effects from shadow flicker would be **not significant** as per the EIA Regulations.

15.1.9 Summary of Effects

An assessment of shadow flicker effects arising from the operation of the Development has been carried out. The assessment includes a number of worst-case assumptions, and it is anticipated that in practice, the duration of shadow flicker effects will be substantially lower than presented in this report.

However, based upon this conservative approach, up to 11 properties have the potential to experience shadow flicker in excess of the assessment criteria without mitigation. Mitigation measures will therefore be applied to the Development to ensure that shadow flicker levels remain below the recommended assessment criteria at all properties.

15.1.10 Statement of Significance

No shadow flicker effects will occur during construction or decommissioning.

The effect of shadow flicker during the operational period has been assessed using appropriate guidance. With the implementation of appropriate mitigation, shadow flicker effects are considered to be **not significant** in terms of the EIA Regulations, either in isolation or cumulatively.

15.2 TELECOMMUNICATIONS

Consultation with telecommunication operators was undertaken by the Applicant before the EIA Scoping Report (TA A2.2) was issued, with no impacts identified. These operators were consulted again through the Scoping consultation by the Scottish Government, and no potential impacts were identifed. The final turbine design has been a reduction in size of the scheme proposed at scoping and so it can be assumed that there will be no impacts to telecommunication operators.

15.3 WASTE

15.3.1 Introduction

Given the nature of the Development and the construction process no significant quantities of waste are anticipated during the construction and operation phases.

15.3.2 Assessment of Effects

15.3.2.1 Construction Phase

All waste will be removed off-site for safe disposal at a suitably licensed waste management facility in accordance with current waste management regulations. Wherever possible, excavated stone or soils will be re-used on site, primarily for the restoration of disturbed ground. As noted in section 4.2.7, stone that is used for construction tracks, and required by the landowner to be taken up again following construction, will be stored in the construction and storage compound during the operation phase.

Waste handling is included within Technical Appendix A4.2: Outline Construction Environmental Management Plan (oCEMP), a final version of which is to be submitted to Moray Council for approval, in consultation with SEPA, prior to the commencement of the construction phase.

Exact quantities and types of waste likely to be generated during the construction phase are unknown, however it is expected that waste streams could include:

- Hardcore, stone, gravel from temporary surfaces to facilitate construction waste, and concrete;
- Subsoil from excavations for foundations and roads;
- Timber from temporary supports, shuttering and product deliveries;
- Miscellaneous building materials left over from construction of the control building;
- Sanitary waste from chemical toilets (if used);

- Plastics packaging of material; and
- Lubricating oils, diesel - unused quantities at end of construction period.

Waste oils and diesel will be removed from the Site and disposed of by an approved waste contractor in accordance with provisions of the Special Waste Regulations 1996[7].

A Site Waste Management Plan (SWMP) will be agreed as part of the CEMP prior to the commencement of construction.

15.3.2.2 Operational Phase

During the operational phase of the Development the Site would be unmanned, although maintenance personal would be expected to be present on site occasionally. Waste arising is expected to be substantially less that during the construction phase, and could include:

- Welfare facility waste;
- Packaging waste (from replacement components); and
- General waste (paper, cardboard, wood, etc.).

During the operational phase of the Development waste arising are expected to be substantially less that during the construction phase, and so effects are not assessed. Welfare waste would be contained in a septic tank or cesspit, as set out in Chapter 4, and any cesspit would be emptied periodically by a licenced contractor.

15.3.2.3 Decommissioning Phase

The decommissioning phase will involve the removal of the Development, as set out in Chapter 4, Section 4.6.

Arising materials will be recycled, where this is practicable, which is expected to be almost entirely.

Any residual, non-recyclable materials will be disposed of in accordance with legislation in place at that time.

15.4 MAJOR ACCIDENTS AND DISASTERS

The potential for road accidents is addressed in Chapter 11, Traffic and Transport. The potential for chemical leaks, spills and other pollution is addressed in Chapter 12, Hydrology, and subject to control measures set out in TA A4.2, oCEMP. Health and safety during construction is addressed in Chapter 4, Section 4.4.5.

Battery safety is discussed in 15.4.1.

No other major accidents or disasters with consequences for, or from, the Development are likely to occur.

15.4.1 Battery Safety

The Development includes a battery energy storage system (BESS). As set out in Chapter 4 – Development Description, this would include battery containers and associated inverters, transformers and cabling. Batteries are used in a very large number of domestic and commercial appliances, and only rarely fail, and even more rarely fail in a way that could be a hazard. However, as noted by the National Fire Chief's Council (NFCC) guidance[8], "*a number of high profile incidents have taken place and learning from these incidents continues to emerge*".

Potential issues arise when a battery fault occurs, causing the battery to overheat. If overheating continues unchecked, certain battery technologies have risk of thermal runaway and a fire. The fire could spread to other battery cells within the same container, and potentially from container to container, if the fire is sufficiently strong and the containers are close enough and/or without intervening fire protection. The fire can cause toxic smoke, and

[7] UK Government (1996) The Special Waste Regulations 1996. Available at: https://www.legislation.gov.uk/uksi/1996/972/contents/made [Accessed 24/02/2025].

[8] National Fire Chiefs Council (2022). Grid Scale Battery Energy Storage System planning – Guidance for FRS. https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf [accessed on 16/11/2024].

fighting this with water can lead to contaminated water on the ground around the containers. This is a theoretical worst-case scenario, because well-established measures will be in place to prevent this occurring, as set out in this section.

15.4.1.1 *Siting*

The proposed BESS unit (as shown on Figure 4.1), is approximately 520 m at its closest point from the nearest residential property. The BESS is located outside of any environmentally sensitive areas. The BESS has therefore been sited in a suitable location.

15.4.1.2 *Design and Operational Management*

An Outline Battery Safety Management Plan (BSMP) has been prepared for the Development, in order to minimise the risk of, and from, a battery-related fire, and is included as TA A15.1.

There is a substantial body of legislation governing the construction and operation of a BESS facility. This is set out in TA A15.1. This legislation (as may be amended prior to construction of the BESS) will be complied with.

Prior to detailed design of the Development, consultation will be undertaken with the Scottish Fire and Rescue Service. A full and final BSMP will then be developed, based on the Outline BSMP, and submitted for agreement with Moray Council in consultation with the Scottish Fire and Rescue Service prior to the start of construction of the BESS part of the Development.

On this basis, the risks associated with a potential fire in a battery unit are unlikely to be significant.

15.5 TRANSBOUNDARY EFFECTS

In the EIA Regulations, transboundary effects relate to potential effects on other EU member states. The nearest EU member state is the Republic of Ireland, and there is no potential for the Development to have significant effects at that distance.