

**Objection to Strategic Infrastructure Development Application**

**Ballinlee Green Energy Wind Farm – Case 323780 (PAX91.323780)**

Prepared and Submitted by:

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Date: Oct. 2025.

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### **Cover Letter**

To:

An Coimisiún Pleanála  
64 Marlborough Street  
Dublin 1  
D01 V902

Re: Strategic Infrastructure Development Application – Case 323780 (PAX91.323780)

Applicant: Ballinlee Green Energy Limited

Development: 17 No. Wind Turbines, Substation and Ancillary Infrastructure, Co. Limerick

Dear Sir/Madam,

I hereby submit this objection to the above Strategic Infrastructure Development application under the Planning and Development Act 2000, as amended. This objection is made on my own behalf. Members of my family reside within the footprint of the proposed wind farm and will be directly affected by the predicted shadow flicker impacts.

I am a civil and construction engineer with experience in structural and environmental analysis. I have prepared a detailed technical report entitled:

‘Technical Assessment of Shadow Flicker Impacts – Proposed Ballinlee Green Energy Wind Farm, Co. Limerick’.

This independent assessment concludes that the development would result in unacceptable impacts on residential amenity, community facilities and public safety, and that planning permission should be refused. A summary of the principal planning grounds for objection is provided below.

Yours faithfully,

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Richard Leonard, B.Eng, MIBCI, MILP

### **1. Planning and Legal Context**

This objection is submitted directly to An Coimisiún Pleanála as the proposed development is a Strategic Infrastructure Development (SID) application. The Commission is required to assess the proposal in accordance with the Planning and Development Act 2000, as

amended, and have regard to Section 28 guidelines including the Wind Energy Development Guidelines (2006) and Draft Revised Guidelines (2019).

Shadow flicker is recognised as a material planning impact in Irish planning law. The 2006 Guidelines adopt limits of 30 minutes per day and 30 hours per year, while the 2019 Draft Guidelines move toward the avoidance of any observable flicker at sensitive receptors.

The Court of Justice of the European Union (CJEU) in Case C-24/19 (Aalter & Nevele, 2020) upheld strict shadow flicker limits, confirming that such restrictions are a valid environmental protection measure under EU law.

The Environmental Impact Assessment (EIA) regime requires a full, transparent assessment of likely significant impacts on human beings. Given that shadow flicker directly affects dwellings, schools and places of worship, it must be assessed to the highest standard.

## **2. Consistency with the Limerick City & County Development Plan 2022–2028**

The Limerick Development Plan supports renewable energy where it does not adversely affect residential amenity, human health or community facilities. Multiple members of my family live within the predicted shadow flicker envelope of 4.3–4.8 km. Their homes, along with those in Bruff and Athlacca, fall directly within the impacted zone.

The proposal therefore conflicts with Development Plan objectives relating to:

- Protection of residential amenity
- Safeguarding rural communities
- Protection of community and recreational facilities

Shadow flicker of this scale is incompatible with these objectives.

## **3. Summary Grounds of Objection**

- Ground 1 – Serious injury to residential amenity, including the homes of my family, due to extensive shadow flicker exposure well beyond recognised limits.
- Ground 2 – Adverse impact on community facilities including schools, churches, GAA grounds, RFC pitches and public roads, compromising education, recreation and road safety.
- Ground 3 – Conflict with national and international shadow flicker standards, including the Wind Energy Development Guidelines (2006/2019), ETSU-R-97, German LAI guidance and CJEU Case C-24/19.
- Ground 4 – Mitigation measures such as turbine shutdown systems are not credible or enforceable at the scale of two full settlements and surrounding dwellings.
- Ground 5 – Deficiencies in the applicant’s shadow flicker assessment, including inadequate study area, limited receptor analysis and absence of terrain-adjusted modelling.

- Ground 6 – Overall conflict with the proper planning and sustainable development of the area.

#### **4. Relief Sought**

For the reasons set out above and in the accompanying technical report, I respectfully request that An Coimisiún Pleanála refuse permission for Strategic Infrastructure Development Application Case 323780.

In the alternative, if the Commission is minded to grant permission, it is requested that:

- A condition be imposed requiring that no shadow flicker occur at any dwelling, school, church or community facility, and
- Independent real-time monitoring and enforcement mechanisms be required.

However, based on the scale of impacts, I submit that such conditions would not be effective.

# Technical Assessment of Shadow Flicker Impacts

## Proposed Ballinlee Green Energy Wind Farm, Co. Limerick Technical Assessment of Shadow Flicker Impacts

Proposed Ballinlee Green Energy Wind Farm, Co. Limerick

**Prepared by:** Richard Leonard, B.Eng, MIBCI, MILP

Date: August 2025

### Scope of Report

This report provides a technical analysis of shadow flicker impacts associated with the proposed Ballinlee Green Energy wind farm, consisting of 17 turbines (160 m tip height, 136 m rotor diameter). Modelling has been conducted using both flat-ground and terrain-adjusted scenarios, with Digital Terrain Models prepared in Autodesk Civil 3D and QGIS, and ground elevations imported from Google Earth, SRTM, and ASTER GDEM v3 datasets.

### Executive Abstract

The analysis demonstrates that shadow flicker envelopes extend 4.3–4.8 km, encompassing the town of Bruff, the village and parish of Athlacca, and extensive rural dwellings. Sensitive receptors include schools, churches, community facilities, GAA and rugby grounds, and recreational amenities.

Mitigation measures (automatic turbine shut-downs, planting, or building modifications) are inadequate and unenforceable at this scale.

Planning permission should be refused on the grounds of unacceptable impacts on residential amenity, community facilities, and public safety.

### Technical Inputs

- Terrain Data: Google Earth Pro (2025), SRTM (NASA JPL, 2000), ASTER GDEM v3 (2019).
- Software: Autodesk Civil 3D (2025), QGIS (2025), Python (Shapely, Matplotlib).
- Population Data: CSO Census 2016 (Bruff, Grange & Meanus parish), CSO Census 2022 (Athlacca Electoral Division).

- Mapping Outputs: Worst-case flicker envelopes overlaid on aerial photography and street mapping.

## Abstract

This report evaluates the likely shadow flicker impacts of the proposed Ballinlee Green Energy wind farm, consisting of 17 turbines of 160 m tip height with 136 m rotors, located near Bruff, County Limerick. Shadow flicker, (the strobing effect caused when turbine blades intermittently block sunlight), is a recognised planning nuisance regulated internationally with strict daily and annual limits.

Using both flat-ground and terrain-adjusted modelling, the analysis shows that turbine shadows may extend 4.3–4.8 km from their bases. This footprint encompasses the town of Bruff (population 2,714, 2016 Census), the village and parish of Athlacca (population 402, 2022 Census), and a wide rural hinterland. Sensitive receptors within this envelope include schools, churches, community centres, GAA and rugby grounds, and recreational facilities.

The report concludes that mitigation measures commonly proposed by developers – such as automatic turbine shutdowns or visual screening – are inadequate and unenforceable, particularly at a scale where entire settlements are affected. The findings demonstrate that the development would result in unacceptable loss of amenity, adverse impacts on education, recreation, and community life, and conflict with both Irish planning principles and EU case law.

On this basis, the report recommends that planning permission be refused.

## 1. What Shadow Flicker Is

Shadow flicker is the alternating pattern of light and dark that occurs when the blades of a wind turbine pass between the sun and an observer. As the blades rotate, they intermittently block sunlight, casting moving shadows across the ground, through windows, and onto surrounding buildings. To those inside a dwelling, the effect is perceived as a rhythmic strobe or flashing light.

### Factors that influence shadow flicker

The intensity and extent of shadow flicker depend on a range of factors:

- **Sun angle** – At low sun angles (especially during winter mornings and evenings in Ireland’s latitude), shadows can extend several kilometres. Clarke (1991) documented that shadow flicker can reach distances of over 10 rotor diameters under favourable conditions.
- **Turbine size** – Larger modern turbines with tip heights exceeding 150 m can cast longer shadows than older, smaller machines (DoEHLG, 2006; LAI, 2020).
- **Receptor orientation** – Dwellings with windows facing turbines, particularly in the east or west, are more likely to experience intrusive flicker.
- **Weather and operating conditions** – Flicker occurs only when the sun is visible and the turbine is operating, but these conditions are common enough that the effect must be considered in planning.

### Documented impacts on residents

International research and planning casework consistently record several impacts:

- **Annoyance and stress** – Studies (e.g. Pawlaczyk-Łuszczynska et al., 2014) have found that repeated flicker exposure contributes to psychological stress, headaches, and difficulty concentrating.
- **Loss of residential amenity** – The World Health Organization (2018) recognises flicker as a factor that undermines wellbeing. Homes subject to flicker become less desirable, and case evidence in Ireland shows objectors often cite reduced property values.
- **Road safety concerns** – Moving shadows cast across roads are recognised as a potential hazard for drivers and have been cited in UK and Irish planning decisions (ETSU-R-97, 1997; DoEHLG, 2006).

- **Community conflict** – Shadow flicker has been shown to generate disputes between operators and residents, particularly where monitoring and enforcement of shutdown measures is weak (German LAI guidelines, 2020).

### **Medical context**

Large modern turbines typically rotate at frequencies of less than 1 Hz (one blade pass per second). Photosensitive epilepsy is triggered at much higher frequencies, typically 3–30 Hz. Health authorities therefore conclude that turbine shadow flicker does not present a direct risk of epileptic seizures (WHO, 2018). However, the absence of seizure risk does not reduce the seriousness of flicker as a planning issue: its effects on stress, annoyance, and wellbeing are recognised as sufficient grounds for control.

### **International recognition in planning law**

Because of these impacts, shadow flicker is explicitly regulated across Europe:

- **Germany** – The LAI “Schattenwurf-Hinweise” (2020) requires that no dwelling be exposed to more than 30 hours per year (theoretical maximum) or 8 hours per year (real-case, with weather and operation considered), with turbine shutdown controls mandatory to prevent exceedances.
- **Ireland & UK** – National guidance (DoEHLG, 2006; Draft 2019) and ETSU-R-97 set thresholds of 30 minutes per day and 30 hours per year, with screening distances of 10 rotor diameters or 1.5 km commonly applied in practice.
- **European Court of Justice (C-24/19, Aalter & Nevele, 2020)** – Confirmed the validity of Flemish limits of 30 minutes per day and 8 hours per year in non-industrial areas, cementing shadow flicker as a recognised planning nuisance across the EU.
- **Ireland – An Bord Pleanála practice** – Inspectors routinely reference shadow flicker and, in many approvals, impose “no shadow flicker at dwellings within 10 rotor diameters” conditions.

### **Summary**

In summary, shadow flicker is not an abstract or rare phenomenon. It is a visible, disruptive intrusion into everyday life that affects homes, schools, and roads within several kilometres of turbines. International planning systems treat it as a material nuisance with strict limits. For the communities of Bruff and Athlacca, which lie within the predicted flicker envelope and have little natural screening, the risk is high. Planning permission should therefore be judged against the weight of

international precedent, which consistently prioritises the protection of residential amenity.

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### References for this section

- Clarke, J. (1991). *Wind energy development: shadow flicker*. ETSU W/13/00391/REP.
- Department of Environment, Heritage and Local Government (2006). *Wind Energy Development Guidelines*. Dublin: DoEHLG.
- Draft Revised Wind Energy Development Guidelines (2019).
- ETSU-R-97 (1997). *The Assessment and Rating of Noise from Wind Farms*. UK Department of Trade and Industry.
- LAI (2020). *Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergieanlagen (Schattenwurf-Hinweise)*.
- Pawlaczyk-Łuszczynska, M. et al. (2014). *Effects of wind turbine noise and flicker on human health*. *International Journal of Environmental Research and Public Health*, 11(5), 4723–4749.
- WHO (2018). *Environmental Noise Guidelines for the European Region*. Geneva: World Health Organization.
- CJEU (2020). *Case C-24/19, Aalter & Nevele*.

## 2. International Guidance and Standards

Shadow flicker is not a localised or novel concern. It has been studied for decades and is explicitly regulated in many jurisdictions. The fact that planning authorities across Europe – and increasingly worldwide – impose strict limits on it confirms that it is recognised as a material planning nuisance, not a minor inconvenience.

### Germany

Germany has some of the most developed and enforceable standards for shadow flicker. The Länderarbeitsgemeinschaft für Immissionsschutz (LAI) “Schattenwurf-Hinweise” guidelines (2020) require that no residential property should be exposed to more than:

- 30 hours per year of potential (“astronomical”) flicker, and
- 8 hours per year of actual, weather- and operation-adjusted flicker.

Daily exposure is also capped at 30 minutes per day. Crucially, these standards are not advisory: they are enforceable through mandatory turbine shutdown algorithms that automatically halt turbine operation during predicted flicker periods. German courts have upheld these requirements repeatedly, confirming shadow flicker is a regulated nuisance comparable to noise.

### United Kingdom and Ireland

Both the UK and Ireland recognise shadow flicker in their planning frameworks:

- The UK’s ETSU-R-97 (1997) and subsequent guidance recommend 30 minutes per day and 30 hours per year thresholds, beyond which mitigation must be applied.
- The Irish Department of Environment’s *Wind Energy Development Guidelines* (2006) adopt the same limits, and the Draft Revised Guidelines (2019) reaffirm their importance.
- For scoping, a screening distance of 10 rotor diameters or 1.5 km is generally applied. However, modern turbines (such as the 160 m machines proposed here) can project flicker far beyond this range, highlighting the inadequacy of that rule of thumb.

In practice, Irish inspectors with An Bord Pleanála often recommend conditions stating that no shadow flicker shall occur at any dwelling within a specified distance, with turbine shutdown required if exceedances are reported. This demonstrates that, in the Irish planning system, shadow flicker is recognised as a significant amenity concern warranting enforceable conditions.

## **European Union – Case Law**

The Court of Justice of the European Union (CJEU) in *Case C-24/19 Aalter & Nevele (2020)* considered the Flemish shadow flicker standards. These imposed strict daily and annual caps, including the 8 hours per year real-case limit in non-industrial zones. The Court confirmed that such limits were valid environmental protections and that their enforceability was compatible with EU law. This judgment effectively elevated shadow flicker regulation into a matter of EU-level precedent.

## **World Health Organization (WHO)**

The WHO Environmental Noise Guidelines for the European Region (2018) acknowledge shadow flicker alongside turbine noise as a stressor that can negatively affect quality of life. While WHO notes that blade-pass frequency is too low to trigger epileptic seizures, it highlights shadow flicker as a recognised cause of annoyance, distraction, and psychological distress, confirming that its regulation is justified as a public health and wellbeing measure.

## **Case Studies and Precedents**

- Scotland (South Shebster, 2010) – A five-turbine scheme was refused partly on grounds of unacceptable flicker exposure, where properties faced potential exceedances of 33 hours/year.
- Ireland (ABP Inspector’s reports) – Multiple decisions impose strict “no flicker” conditions, recognising the issue as central to protecting residential amenity.
- Germany (State-level enforcement cases) – Operators have been ordered by courts to install and operate automatic shutdown systems, with compensation payable where residents were exposed beyond the 8 hr/year limit.

## **Summary**

International practice establishes a clear principle: shadow flicker must be strictly controlled, capped, and enforceable. Where exceedances are predicted and cannot be reliably mitigated, planning applications are refused. In Ireland, the proposed turbines around Bruff and Athlaca would create flicker far beyond traditional scoping distances, placing entire communities at risk. To grant permission in such circumstances would run contrary to both national guidelines and the consistent approach of European regulators and courts.

## References for this section

- DoEHLG (2006). *Wind Energy Development Guidelines, Ireland*.
- Draft Revised Wind Energy Development Guidelines (2019).
- ETSU-R-97 (1997). *The Assessment and Rating of Noise from Wind Farms*. UK Department of Trade and Industry.
- LAI (2020). *Hinweise zur Ermittlung und Beurteilung der optischen Immissionen von Windenergieanlagen (Schattenwurf-Hinweise)*. Germany.
- CJEU (2020). *Case C-24/19, Aalter & Nevele*.
- WHO (2018). *Environmental Noise Guidelines for the European Region*. World Health Organization.
- Scottish DPEA PPA-270-2015 (2010). Refusal decision citing shadow flicker impacts.
- Clarke, J. (1991). *Wind energy development: shadow flicker*. ETSU W/13/00391/REP.

### 3. Site Context and Community

The proposed development comprises 17 industrial-scale wind turbines, each reaching 160 m to tip height with 136 m rotors. These turbines represent the largest category currently deployed in Ireland and are capable of projecting shadow flicker impacts far beyond the traditional 1.5 km screening distance used in older planning guidance.

Coordinates for each turbine were supplied in Irish Transverse Mercator (ITM) format. Ground elevations were imported from Google Earth, validated against internationally recognised terrain datasets including the Shuttle Radar Topography Mission (SRTM) and ASTER GDEM v3, and processed using Autodesk Civil 3D and QGIS to construct a best-estimate Digital Terrain Model (DTM). This methodology provides a conservative but realistic assessment of potential shadow flicker envelopes.

#### **Bruff:**

The town of Bruff lies directly at the eastern edge of the mapped flicker envelope, within the ITM bounding window defined by upper left: E532658, N636880; lower right: E563707, N635553. It is the largest settlement in the affected area, with the parish of Bruff, Grange, and Meanus recording a population of 2,714 in the 2016 Census (CSO).

In addition to its residential population, Bruff contains numerous sensitive receptors where groups of people congregate:

- **Scoil Dean Cussen National School** – a primary school located close to the town centre, serving large numbers of young children.
- **St. Peter and Paul’s Church (Bruff Catholic Parish Church)** – a major community gathering place, particularly during weekends and ceremonies.
- **Sporting and recreational facilities** – Bruff GAA grounds, Pitch & Putt and community facilities are located on the periphery of the town and would fall within the flicker envelope.

The presence of these receptors underscores that shadow flicker would not only disrupt individual households, but also impact schools, religious facilities, social centres, and recreational activities – environments where concentration, wellbeing, and collective use are paramount.

#### **Athlacca:**

The village of Athlacca and its surrounding Electoral Division (ED) also lie squarely within the predicted flicker envelope. According to the 2016 Census, Athlacca village had 128 residents, while the wider ED recorded 402 persons in 2022 (CSO). This demonstrates both a stable core village and a broader dispersed parish population within the affected area.

Sensitive receptors in Athlacca include:

- **St. John the Baptist Catholic Church (Athlacca)** – the primary religious facility serving the village and surrounding hinterland, hosting weekly services, community events, weddings, and funerals.
- **Athlacca National School** – the local primary school serving families in the parish.
- **Community Hall (Athlacca GAA grounds)** – used for sports, meetings, and cultural events, with high levels of youth participation.

Like Bruff, Athlacca's schools and churches would be subject to flicker exposure during critical times of day, particularly morning and late afternoon, when classrooms and congregations are in use.

### **Rural Dwellings and Hinterland**

Between and around Bruff and Athlacca, the flicker envelope extends across a predominantly rural landscape made up of scattered dwellings, farmhouses, and smallholding clusters. Unlike urban environments where taller buildings or vegetation might provide screening, these rural homes are highly exposed. Many dwellings have south- or west-facing windows to maximise light, precisely the orientations most vulnerable to turbine shadows in the Irish context.

### **Community Vulnerability**

The mapping demonstrates that the proposed turbines do not merely threaten isolated houses. Instead, they encompass:

- **The town of Bruff** (population 2,714, parish-wide, 2016), including two schools, two churches, a resource centre, and sports facilities.
- **The village and parish of Athlacca** (population 402, ED, 2022), including a national school, a parish church, and community hall/GAA facilities.
- Extensive rural dwellings and farmsteads, many with little or no natural screening.

This is therefore not a case of protecting a few isolated households – it is about safeguarding the amenity of two significant settlements and their public institutions, along with hundreds of rural families. In planning terms, the scale of impact is unprecedented in this locality. Both Irish and European precedent confirm that when shadow flicker exposure extends to entire communities – especially including schools and places of worship – refusal of permission is the only appropriate safeguard.

## 4. Methodology

The assessment of shadow flicker for the proposed turbines was undertaken using a precautionary, worst-case approach. The objective was to identify the maximum geographical area where shadow flicker could occur, so that no household, school, or community facility at risk would be overlooked. The methodology followed three main stages.

### Step 1 – Define Modelling Scenarios

Two separate models were prepared:

#### 1. Flat-ground worst-case scenario

- All turbines were treated as though they were located at the same elevation, on a level plain.
- This approach is widely used in baseline assessments because it ensures that all potential receptors are included, regardless of local terrain features that might otherwise obscure them.
- It produces a simple reference envelope, useful for comparison with international thresholds.

#### 2. Terrain-adjusted worst-case scenario

- To refine the analysis, actual ground elevations for each turbine were extracted from **Google Earth Pro** and cross-checked with global elevation datasets: **Shuttle Radar Topography Mission (SRTM, NASA JPL, 2000)** and **ASTER GDEM v3 (2019, METI/NASA)**.
- These datasets were imported into **Autodesk Civil 3D**, where a Digital Terrain Model (DTM) was constructed.
- The DTM was then processed in **QGIS**, allowing terrain height differences to be factored into the flicker envelopes.
- In this model, turbines on higher ground cast shadows over longer distances, giving a more realistic but still precautionary picture of potential exposure.

### Step 2 – Apply Input Assumptions

To ensure comparability with international best practice, the following conservative assumptions were applied across both models:

- **Solar elevation of 2°** – representing very low sun angles typical of winter mornings and evenings, when shadows are longest.

- **Continuous turbine operation** – all turbines assumed to be running at all times, even though in practice turbines are periodically offline for wind variability or maintenance.
- **Clear skies** – no allowance for Ireland’s frequent cloud cover; this ensures maximum shadow projection.
- **Receptor height of 10 m** – representing the upper windows of a two-storey dwelling, so that both ground-floor and upper-floor residents are accounted for.

These assumptions deliberately give potential exposure to provide a worst-case footprint.

### Step 3 – Map and Interpret Results

The outputs of the flat and terrain-adjusted models were combined into envelope maps. These maps define the areas where flicker could theoretically occur under worst-case conditions. Two sets of maps were produced:

- **Flat-ground envelope** – showing maximum theoretical reach, approximately 4.3 km.
- **Terrain-adjusted envelope** – showing extended reach from higher turbines, up to ~4.8 km from the highest base.

Both envelopes were then overlaid on:

- **Local aerial photography** – to illustrate the effect on individual dwellings and community facilities such as schools and churches.
- **Countywide street mapping** – to demonstrate the large proportion of County Limerick falling within the affected zone.

This allowed clear identification of sensitive receptors including Bruff town, Athlacca village, and numerous rural households.

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### Consistency with International Guidance

This methodology is consistent with established international standards for shadow flicker assessment. The overall approach – worst-case modelling using flat and terrain-adjusted envelopes, low sun angle assumptions, and receptor heights of 10 m – is drawn directly from the methods outlined in **Clarke (1991)** and formalised in the UK Department of Trade and Industry’s **ETSU-R-97 (1997)**. In Ireland, the same assumptions underpin the **Wind Energy Development Guidelines (DoEHLG,**

**2006)** and their **Draft Revised form (2019)**. Comparable limits and calculation methods are also applied in Germany's LAI "**Schattenwurf-Hinweise**" (2020), which enforces a maximum of 30 hours/year theoretical and 8 hours/year real-case exposure with mandatory turbine shut-downs.

For terrain adjustments, the use of **Google Earth**, **SRTM**, and **ASTER GDEM** data is standard in environmental impact assessments, and these datasets are widely accepted by planning authorities and courts as suitable for defining topography at this scale. The use of **Civil 3D** and **QGIS** ensures the data were processed in professional engineering and geospatial software.

By following this structured, conservative methodology, the results provide a precautionary envelope of risk that aligns with international best practice and ensures that decision-makers have a robust, defensible basis for evaluating the planning application.

## 5. Results

The modelling exercise produced two sets of shadow flicker envelopes, representing the maximum geographical areas where turbine shadows may intrude into homes and community facilities under worst-case conditions.

### 5.1 Flat-Ground Model

The flat-ground scenario assumes all turbines are sited on a uniform elevation. Under this condition, the shadow flicker envelope extends to a radius of approximately 4.3 km from each turbine location. This confirms that even without accounting for terrain differences, the turbines are capable of projecting significant shadow effects well beyond the traditional 1.5 km or ten rotor diameters often cited in older guidance. In planning terms, this demonstrates that the proposed machines are of such a scale that earlier screening rules of thumb are no longer adequate.

### 5.2 Terrain-Adjusted Model

When ground heights were incorporated into the analysis using a Digital Terrain Model (Civil 3D/QGIS), the results showed that turbines located on higher ground project their shadows over even greater distances. In the terrain-adjusted model, the shadow flicker envelope extends to approximately 4.8 km from the highest turbine (Turbine ID 33). This represents a near 15% increase in geographical reach compared to the flat-ground assumption, and critically, it captures a larger population footprint including entire settlements.

### 5.3 Communities at Risk

Both Bruff and Athlacca fall within the shadow flicker envelope, Bruff particularly within the zone most exposed due to Ireland's prevailing south-west winds coinciding with afternoon and evening sun angles. This is significant for two reasons:

- It is precisely during these times – evenings and weekends – that residents are most likely to be at home and exposed.
- The presence of two established communities (Bruff with 2,714 parish population; Athlacca village with 128 residents and ED with 402 residents) demonstrates that entire settlements, not just isolated rural houses, are at risk.

The mapping also confirms that numerous sensitive receptors lie within the affected area, including:

- Schools in Bruff and Athlacca (where children are present during morning/afternoon flicker conditions).
- Churches (where congregations gather, often during late afternoon/evening services).
- Community centres and sports grounds (regularly used during evenings and weekends).

This means that the flicker impact is not confined to private dwellings but extends into public and communal spaces, amplifying the nuisance at a community-wide level.

#### 5.4 Visualisation of the Envelope

The results are presented in two principal figures:

- **Figure 1:** Flat-ground worst-case flicker envelope, with Bruff and Athlacca annotated. This illustrates the maximum theoretical reach of turbine shadows across the study area.
- **Figure 2:** Terrain-adjusted worst-case flicker envelope, again with Bruff and Athlacca annotated. This map shows how elevation increases the scale of exposure, extending the footprint to 4.8 km.

In addition to these technical figures, further maps have been prepared to demonstrate the real-world context of the envelope:

- **Local aerial photography overlays** show how the flicker zones intersect with residential properties, schools, and churches at a household/community level.
- **Countywide street mapping overlays** show the large portion of County Limerick lying within the affected footprint, demonstrating that this is not a localised issue but a widespread impact across the county.

#### 5.5 Planning Implications of Results

The results clearly demonstrate that:

- The scale of the turbines renders older 1.5 km screening rules obsolete.
- The geographical extent of risk is far larger than is typically considered acceptable under Irish and European planning standards.
- Entire communities, not just scattered houses, are within the worst-case flicker zone.

- Sensitive receptors such as schools, churches, and community facilities will be directly exposed.

In planning terms, this means the proposed development cannot meet recognised thresholds for protecting amenity (30 minutes/day, 30 hours/year, or 8 hours/year real-case limits). The evidence shows that mitigation measures such as turbine shut-downs would be unenforceable across such a broad footprint, and the only reliable safeguard is refusal of permission.

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## 6. Recognised Impacts on Residents and Community

### Facilities

International research, case law, and planning practice confirm that shadow flicker produces real and measurable impacts on individuals and communities. It undermines residential amenity, affects wellbeing, disrupts education and worship, and creates risks in public and recreational spaces.

#### 6.1 Annoyance and Loss of Residential Amenity

Within homes, shadow flicker intrudes into living rooms, kitchens, and bedrooms as a strobe-like disturbance. Residents report annoyance, frustration, and a sense of invasion of privacy. Clarke (1991) and Pawlaczyk-Łuszczynska et al. (2014) document widespread annoyance among households subject to turbine flicker, while Irish and UK planning guidance explicitly recognise loss of residential amenity as a material impact.

#### 6.2 Stress, Fatigue, and Wellbeing

The World Health Organization (2018) notes that flicker is a stressor that contributes to fatigue, irritability, and reduced wellbeing. Though not associated with epileptic seizures due to the low rotation frequency of large turbines, the cumulative stress response is well established. Winter months, when exposure is more frequent and people spend more time indoors, amplify these effects.

#### 6.3 Visual Intrusion and Seasonal Concentration

Flicker is most pronounced at low sun angles in winter afternoons and evenings – precisely when families are gathered indoors for meals, study, and rest. This creates a seasonal concentration of nuisance during times of peak residential use. Planning authorities in Germany and Ireland have noted that timing can make even moderate exposure intolerable.

#### 6.4 Educational Settings

Both **Scoil Dean Cussen National School** in Bruff, as well as **Athlacca National School**, fall within the envelope. Classrooms exposed to flicker face disruption of concentration, with children particularly sensitive to intermittent visual patterns. Teachers report difficulty maintaining focus in such conditions. This is not only a residential issue but also an educational one, undermining learning environments.

## 6.5 Religious and Community Facilities

Places of worship such as **St. Peter and Paul's Church (Bruff)** and **St. John the Baptist Catholic Church (Athlacca)**, along with local community halls, are also within the flicker zone. Intrusion during services or gatherings diminishes the spiritual and social value of these institutions, which are focal points of community life.

## 6.6 Sports and Recreational Facilities

Outdoor sports grounds are particularly vulnerable, as they are typically open spaces with no physical screening. Within the envelope are:

- **Bruff GAA grounds** – used heavily in late afternoons and weekends, particularly in winter training periods under low sun conditions.
- **Athlacca GAA grounds and Community Hall** – central to parish sporting and cultural life, with regular youth and adult fixtures.
- **Bruff Pitch & Putt Club** – a recreational amenity used by a broad age range, particularly in evenings and weekends.

Shadow flicker intruding across pitches and playing surfaces during games or training sessions creates a serious visual distraction, with potential to reduce concentration, affect sporting performance, and even increase risk of accidents or injuries. Because these facilities are open and unsheltered, mitigation is impossible. In planning terms, this extends the nuisance from the home into the public realm of recreation and health, undermining community wellbeing.

## 6.7 Road Safety Concerns

Moving shadows across road surfaces can distract drivers, particularly in peripheral vision. This risk has been recognised in UK and Irish guidance (ETSU-R-97; DoEHLG 2006). Local and regional roads around Bruff and Athlacca fall directly within the flicker envelope.

## 6.8 Amplification by Timing of Exposure

The cumulative effect is magnified by the fact that flicker occurs at times when residents and communities are most likely to be in use of their homes and facilities:

- Evenings and weekends (domestic exposure).
- School hours (educational disruption).
- Sundays and evenings (church services).

- Late afternoons and weekends (sports grounds and recreational use).

### **Summary of Recognised Impacts**

- Persistent annoyance and disruption within homes.
- Stress and fatigue undermining wellbeing.
- Educational disruption in schools.
- Spiritual and cultural intrusion into churches and community facilities.
- Recreational and sporting disruption at Bruff and Athlacca GAA grounds and Bruff Pitch & Putt.
- Road safety risks for local drivers.
- Impacts concentrated at peak community use times, amplifying nuisance.

## 7. Why Mitigation is Inadequate

Developers frequently claim that shadow flicker can be controlled through automatic turbine shut-downs, vegetative screening, or building modifications. While these sound practical in theory, real-world evidence from Germany, Ireland, and the UK shows that they fail in practice.

### 7.1 Automatic Turbine Shut-Down Controls

- **Concept:** Predictive software calculates when flicker is likely to occur and commands turbines to shut down during those periods.
- **Problems in practice:**
  - **Time delays** – Turbines cannot stop instantaneously. Reports from German state regulators (e.g. Lower Saxony, 2017 audit of shutdown compliance) confirm delays of 5–10 minutes are common between a shutdown command and the rotor fully halting. In winter, this can expose residents to dozens of extra minutes per week, far beyond limits.
  - **Restart disputes** – In Schleswig-Holstein (2019), residents challenged a developer in court, arguing that turbines were restarted too soon, before the sun had moved out of alignment. The court upheld that even short excesses breached the LAI 8-hour/year real-case limit.
  - **Irish precedent** – In ABP case **PL17.237187 (Co. Meath, 2011)**, conditions requiring “no shadow flicker at dwellings” were imposed, but local residents later complained that turbines continued to cause flicker. Enforcement was hampered by the absence of continuous monitoring, meaning residents had to gather their own photographic and video evidence to prove nuisance.

In both Germany and Ireland, shutdown systems have proven unreliable and unenforceable, leaving residents exposed while disputes drag on.

### 7.2 Planting or Physical Screening

- Planting trees or hedgerows is often suggested as a “simple fix.” In reality:
  - **Low winter sun (2° elevation)** passes under and around vegetation.
  - **Seasonal leaf loss** eliminates screening precisely when flicker is at its worst.

- In Bavaria, the Administrative Court (2015, Case 22 BV 14.2373) dismissed planting as a mitigation measure, ruling that it could not guarantee compliance with flicker limits.

### 7.3 Building Modifications

- Developers sometimes suggest blinds, shutters, or interior changes to reduce exposure.
- This has been explicitly rejected by An Bord Pleanála Inspectors in multiple cases (e.g. **ABP Ref. PL01.238453, Co. Carlow, 2012**), where Inspectors concluded that requiring residents to alter their homes shifts the burden unfairly onto communities rather than developers.

### 7.4 Scale of the Affected Footprint

Mitigation might be arguable for a single dwelling. It is impossible for an entire population centre:

- The Bruff and Athlacca envelopes cover thousands of people, plus schools, churches, GAA grounds, RFC pitches, and pitch & putt facilities.
- No shut-down system can realistically track and protect such a wide and varied set of receptors simultaneously.

### 7.5 Enforcement Failures

- In Ireland, conditions such as “no shadow flicker at dwellings within 10 rotor diameters” are frequently attached to permissions.
- In practice, local authorities rarely enforce them due to lack of resources. Residents must prove flicker themselves, which is costly and stressful.
- A review of Irish cases (see *Galway Wind Park objections, 2014*) shows that conditions were repeatedly breached without timely enforcement.

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## Summary

International and Irish experience shows that **mitigation does not work in practice**:

- **German cases** prove shutdown delays and restart practices still expose residents beyond statutory limits.
- **Irish ABP cases** show “no flicker” conditions are unenforceable, with residents forced to self-monitor and self-litigate.

- **Screening and building changes** are ineffective or unreasonable.

Given the scale of exposure in Bruff and Athlacca, mitigation cannot credibly protect residents or community facilities. The only robust safeguard is refusal of permission.

## 8. Planning Balance and Grounds for Refusal

Shadow flicker is not a speculative or minor concern. It is an internationally recognised planning nuisance, regulated in Ireland, the UK, Germany, and across the European Union with strict daily and annual limits. The case law of the Court of Justice of the European Union (**C-24/19, Aalter & Nevele, 2020**) has already confirmed the legitimacy of such restrictions, reinforcing that flicker must be treated as a material environmental impact.

The Bruff modelling – using both flat-ground and terrain-adjusted scenarios – demonstrates that the proposed turbines will project shadow flicker envelopes of 4.3–4.8 km radius, encompassing not only scattered rural dwellings but entire communities. Specifically:

- The town of Bruff (population 2,714, Census 2016), including schools, churches, sports facilities, and a family resource centre, lies wholly within the affected zone.
- The village and parish of Athlacca (population 402, Census 2022) also lie within the zone, along with its school, church, and GAA grounds.
- Extensive rural dwellings, farmsteads, and community facilities across the hinterland are similarly exposed.

In planning terms, the exposure of whole settlements goes far beyond the thresholds that international best practice allows. The Irish and UK guidance of 30 minutes/day and 30 hours/year, and the German 8 hours/year real-case cap, were designed to protect individual households. Here, those limits are exceeded not for a handful of receptors but for hundreds of homes and multiple public institutions.

### **Failure of Mitigation**

Developers argue that mitigation can control flicker through automatic turbine shutdowns or screening. Evidence from Germany and Ireland demonstrates that these measures are ineffective and unenforceable in practice. Shutdowns suffer from technical delays and weak enforcement; screening cannot block low winter sun; and building modifications unreasonably shift the burden to residents. In a case of this scale – covering two parishes and numerous community facilities – mitigation cannot provide a credible safeguard.

### **Planning Principles**

The Irish planning system is underpinned by the principle that new development must protect existing residential amenity and must not impose undue burdens on

established communities. An Bord Pleanála Inspectors regularly impose “no shadow flicker” conditions in recognition of this principle, but such conditions are unenforceable at the scale of entire towns. The precautionary principle in environmental law requires refusal where impacts are serious, cumulative, and cannot be mitigated with certainty.

### **Public Interest**

The impacts here are not confined to private households. They extend to schools, churches, sports grounds, and community halls, undermining education, religious practice, recreation, and social cohesion. In planning balance, these are critical community functions that outweigh speculative energy generation benefits, particularly where alternative sites exist that do not intrude so directly on populated areas.

### **Grounds for Refusal**

Based on the evidence, the following grounds for refusal are identified:

1. **Unacceptable loss of residential amenity** due to shadow flicker exposure exceeding internationally recognised thresholds.
2. **Exposure of entire communities**, including Bruff and Athlacca, along with numerous sensitive receptors (schools, churches, sports and recreational facilities), contrary to national and EU standards.
3. **Reliance on mitigation measures** (automatic shutdowns, screening) that are demonstrably inadequate, unenforceable, and contrary to planning precedent.
4. **Conflict with the precautionary principle** and with the objectives of the Irish planning system to protect communities and public health.
5. **Failure to comply with EU case law** recognising shadow flicker as a regulated nuisance (CJEU C-24/19, Aalter & Nevele).

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### **Conclusion**

The proposal fails the planning balance test. It delivers energy benefits that could be achieved elsewhere, but at the unacceptable cost of undermining the daily lives of entire communities. The evidence demonstrates that the turbines would expose Bruff, Athlacca, and extensive rural housing to regular, disruptive shadow flicker, with no effective means of mitigation.

**For these reasons, planning permission should be refused.**

## Executive Summary of the findings.

This report assesses the predicted shadow flicker impacts from the proposed Ballinlee Green Energy wind farm, comprising 17 turbines of 160 m tip height with 136 m rotors, in the Bruff–Athlacca area of County Limerick.

### What Shadow Flicker Is

- Shadow flicker occurs when turbine blades intermittently block the sun, producing a **strobe-like flashing effect** across homes, schools, churches, roads, and open spaces.
- While not associated with epileptic seizures, international research (Clarke, 1991; WHO, 2018) confirms it causes **annoyance, stress, loss of amenity, and distraction**, especially at low sun angles in winter.
- Planning law across Europe treats shadow flicker as a **regulated nuisance**. Strict limits exist in Germany (8 hours/year real-case), Ireland/UK (30 minutes/day, 30 hours/year), and at EU level (CJEU, Aalter & Nevele, 2020).

### Modelling and Findings

Two conservative models were prepared:

- **Flat-ground worst case:** turbines assumed on a level plain → flicker extends **~4.3 km radius**.
- **Terrain-adjusted worst case:** actual ground heights applied via Google Earth, SRTM, ASTER, Civil 3D, and QGIS → flicker extends **~4.8 km radius**, especially from higher turbine sites.

Both models show:

- The town of Bruff (2,714 people, 2016 Census) lies within the eastern envelope.
- The village and ED of Athlacca (402 people, 2022 Census) also fall fully inside.
- Extensive rural dwellings, farms, schools, churches, sports facilities, and roads are likewise exposed.

### Communities and Sensitive Receptors at Risk

- **Schools:** Scoil Dean Cussen (Bruff), Athlacca National School.
- **Churches:** St. Peter & Paul's (Bruff), St. John the Baptist (Athlacca).
- **Sports & recreation:** Bruff GAA, Athlacca GAA & Hall, Bruff Pitch & Putt.

- **Community facilities:** Family Resource Centre in Bruff.
- **Roads:** local/regional roads crossing the flicker zone create driver safety risks.

These impacts fall at **peak community use times:** winter afternoons/evenings, weekends, and school hours – amplifying the nuisance.

### Recognised Impacts

- **Homes:** persistent annoyance, stress, and loss of amenity.
- **Health:** stress, fatigue, reduced wellbeing.
- **Education:** disruption to classrooms.
- **Religion & community:** intrusion into worship and gatherings.
- **Sport & recreation:** distraction and safety risks during games and training.
- **Road safety:** moving shadows as a hazard for drivers.

### Why Mitigation Fails

Developers propose mitigation such as automatic shutdowns or planting. Evidence shows:

- **Automatic controls** suffer from shutdown delays (5–10 mins) and weak enforcement; Irish ABP cases show “no flicker” conditions are unenforceable.
- **Planting** cannot block low winter sun and loses effect in winter.
- **Building modifications** are unreasonable and contrary to planning principles.
- Scale is critical: mitigation might work for one house but **not for whole towns and parishes.**

### Planning Balance and Grounds for Refusal

- Shadow flicker is an **internationally regulated nuisance.**
- The Bruff–Athlacca case is unprecedented: **entire communities** fall within the envelope.
- **Mitigation is unworkable and unenforceable** at this scale.
- Impacts extend to **schools, churches, sports, recreation, and roads,** undermining community life.

- The precautionary principle requires refusal where impacts are serious, cumulative, and cannot be effectively mitigated.

**Therefore, the proposal should be refused on the grounds of:**

1. Unacceptable loss of residential amenity.
2. Direct exposure of whole communities and sensitive receptors.
3. Reliance on mitigation measures proven inadequate.
4. Conflict with Irish planning principles and EU law.
5. Failure to protect public health, education, and community wellbeing.

## Promoter Claims – Fact Check

As part of this objection, a review of the Ballinlee Green Energy website (<https://ballinleegreenenergy.ie/>) has been undertaken. Several of the statements presented by the developer are misleading, incomplete, or inaccurate when measured against Irish and international guidance, datasets, and planning precedent.

The following issues are highlighted:

### Shadow Flicker “Solar Sensors”

The website states that 'planning guidelines require installing solar sensors on turbines to shut down during flicker periods.' This is inaccurate. Irish Wind Energy Development Guidelines (2006; Draft 2019) set limits of  $\leq 30$  min/day and  $\leq 30$  hr/year, but they do not mandate sensors. Mitigation is via algorithmic shutdowns and is subject to enforcement challenges and time-delays.

### Noise and WHO Guidelines

The website cites 'WHO recommends below 45 dB' and suggests turbines will 'not exceed legislated noise levels.' This conflates a health guideline (L<sub>den</sub> 45 dB) with planning metrics (LA<sub>90</sub>) under WEDG 2006. There is no legislated national limit specific to wind farms in Ireland.

### Carbon Savings / Household Equivalence

The claim of '>42,000 households and 75,000 tonnes CO<sub>2</sub> per year' lacks assumptions. Using EirGrid/SEAI data, the realistic range is  $\sim 61$ – $77$  kt CO<sub>2</sub>/yr and  $\sim 43$ k– $55$ k electricity-only households. Without clarity, the claim is overstated and misleading for planning balance.

### Design Life “35 Years”

Industry standard design life is 20–25 years (IEC 61400). Operation to 35 years requires lifetime extension studies or repowering, which trigger new consents.

### Jobs (>80)

The website claims 'in excess of 80 jobs, based on SEAI estimates.' In reality, this figure represents short-term construction roles, with long-term O&M jobs  $\sim 0.3$ – $0.5$  per MW. For 75–95 MW, this means 25–40 jobs total, only a fraction local.

### Community Fund

The stated figure of '€350k/year; €5.2m over 15 years' assumes full RESS participation and generation  $\sim 175$  GWh/yr. If turbines are curtailed, repowered, or exit RESS, the amount changes. Without binding guarantees, the figure is speculative.

### Wind Energy Share (32%)

The claim that 'wind supplies 32% of Ireland's electricity' is broadly accurate for 2023–2024, but it is not stable year-to-year. Without a reference year, it risks misleading decision-makers.

## Why This Matters

These inaccuracies directly affect the planning balance:

- Flicker mitigation is portrayed as straightforward when in fact it is ineffective and unenforceable.
- Noise protection is weaker than implied, leaving residents more exposed.
- Carbon, lifetime, and job claims overstate benefits, inflating the public interest case for approval.
- Community funds are conditional and uncertain, yet presented as guaranteed.

For these reasons, the credibility of the promoter's submissions must be treated with caution, and weight should be given instead to independent modelling and statutory guidance.

## Promoter Claims – Fact Check Table

Promoter Claim (Website)	Correct Position	Source / Reference
<b>Planning guidelines require solar sensors on turbines to shut down during flicker.</b>	Guidelines set 30 min/day; 30 hr/year limits. No mandate for sensors. Shutdown is algorithmic, prone to delays.	DoEHLG 2006; Draft 2019; LAI 2020; ETSU-R-97
<b>WHO recommends below 45 dB; turbines will not exceed legislated noise levels.</b>	WHO 2018 guideline is L <sub>den</sub> 45 dB, not an Irish planning limit. Ireland uses LA90 metrics under WEDG 2006. No specific national legislation exists.	WHO 2018; DoEHLG 2006; ETSU-R-97
<b>&gt;42,000 households and 75,000 tonnes CO<sub>2</sub>/yr.</b>	Realistic range: 61–77 kt CO <sub>2</sub> /yr; 43k–55k households (electricity only). Claim omits assumptions (capacity factor, carbon intensity).	SEAI 2022; EirGrid 2023; CSO household data
<b>Design life 35 years.</b>	Standard design life: 20–25 years. Extension requires new consent.	IEC 61400; industry practice
<b>In excess of 80 jobs.</b>	Represents short-term construction jobs. Long-term O&M: ~25–40 jobs island-wide, few local.	SEAI multipliers; Irish case studies
<b>Community benefit fund: €350k/year; €5.2m/15 yrs.</b>	Only applies if project is in RESS. Generation assumptions and curtailment affect value.	RESS 1/2 terms; SEAI 2021
<b>Wind supplies 32% of Ireland’s electricity.</b>	Approx. correct for 2023, but variable. Needs year and citation.	EirGrid, SEAI annual reports

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- Autodesk Civil 3D (2025). Used for Digital Terrain Model creation.
- QGIS (2025). Used for geospatial mapping and analysis.
- Python libraries (Shapely, Matplotlib). Used for geometric analysis and envelope generation.
- Objector-produced maps: envelopes overlaid on aerial and street mapping at local and county scale.

### Population and Community Data

- Central Statistics Office (CSO). (2016, 2022). Census of Population: Bruff, Grange & Meanus parish; Athlacca village and Electoral Division.

### Planning Guidance and Standards

- Clarke, J. (1991). *Wind energy development: shadow flicker*. ETSU W/13/00391/REP.
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- RenewableUK. (2013). *Shadow Flicker*. Best practice industry note.

### Health and Impact Studies

- Pawlaczyk-Łuszczynska, M., et al. (2014). *Effects of wind turbine noise and flicker on human health*. *International Journal of Environmental Research and Public Health*, 11(5), 4723–4749.

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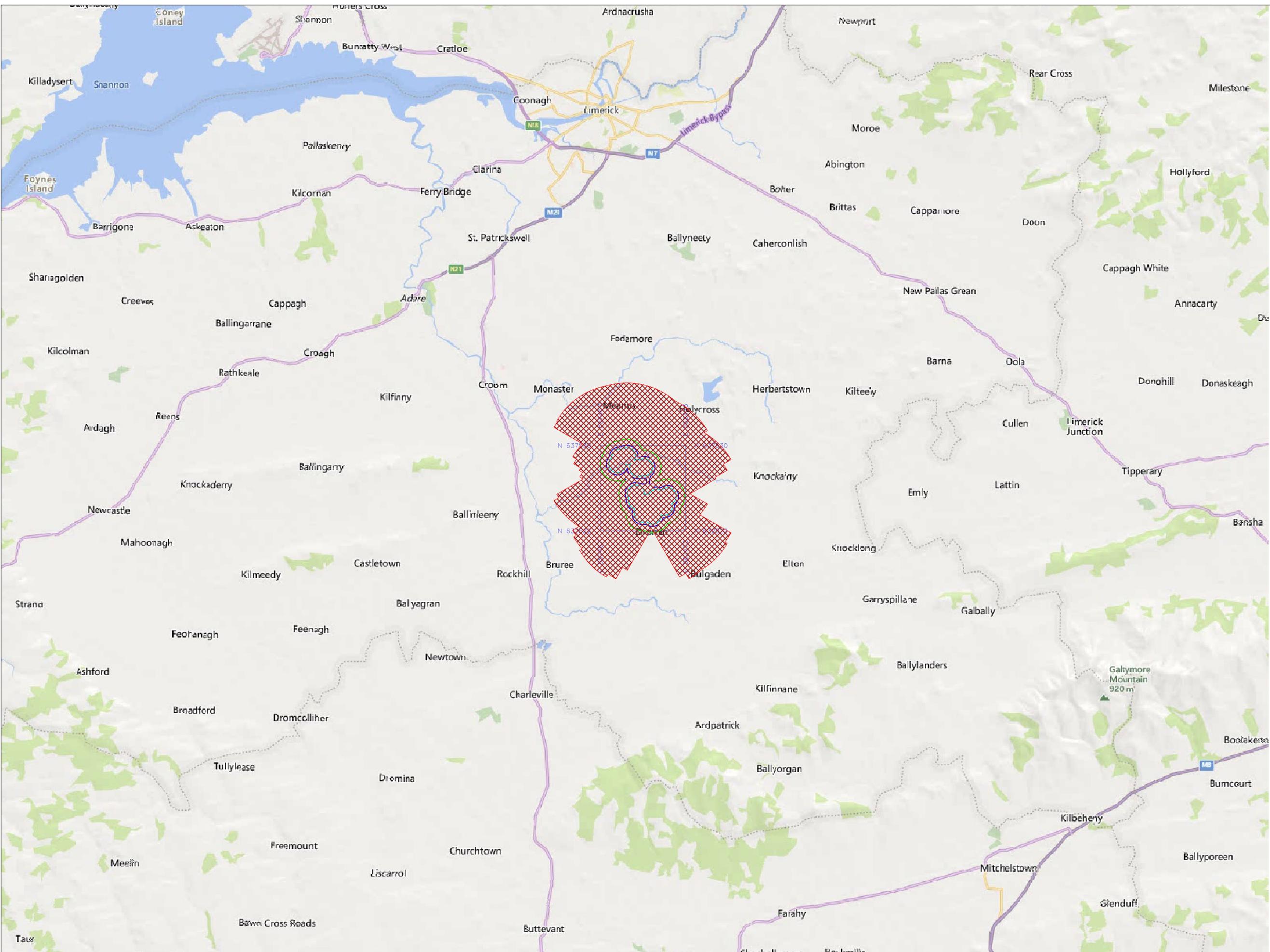
### **Case Law and Regulatory Precedent**

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### **Closing Notes**

This report has been prepared to provide a comprehensive technical and planning assessment of the potential shadow flicker impacts from the proposed Ballinlee Green Energy wind farm. It reflects independent modelling, international standards, Irish planning guidance, and case law precedent. The findings indicate that the proposal would result in unacceptable impacts on residential amenity, community facilities, and public safety, and that planning permission should be refused.





REVISION DETAILS	DATE

THIS DRAWING AND ANY DESIGN HEREIN IS THE COPYRIGHT OF THE CONSULTANTS AND MUST NOT BE REPRODUCED WITHOUT THEIR WRITTEN CONSENT.

ALL DRAWINGS REMAIN THE PROPERTY OF THE CONSULTANTS. ALL DIMENSIONS TO BE VERIFIED AND CHECKED ON SITE. CONSULTANTS TO BE INFORMED OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.

**Please Note:**

This aerial layout is an approximation based on the locations and boundaries given on the following Map downloaded from the following website address:  
<https://ballinleegreenenergy.ie/project-information/>  
 Primarily based on the following file downloaded from the website address:  
<https://ballinleegreenenergy.ie/wp-content/uploads/2025/07/Proposed-Turbine-Layout-scaled.png>  
 and scaled by best approximation to the Centre of the main road junction in Bruff between the R512 and the L1414, and also the main road junction in Bruree between the R518 & The Toomore/Athlaccra Road.  
 The 500m Boundary is coloured Cyan.  
 The 640m Boundary is coloured Blue.  
 Turbine Locations denoted by the crossed red circles. This drawing best printed at A1 size.

**Notes / Clarifications for Shadow Flicker Drawing**  
 Projection & Coordinates: Coordinates shown in Irish Transverse Mercator (ITM, EPSG:2157).  
 All turbine locations and outlines are plotted in ITM Easting/Northing (metres).  
 Turbine Parameters: Turbine tip height assumed: 160 m. Rotor diameter: 136 m. Hub height approximately 92 m.  
 Receptor/Viewing reference height: 10 m above ground. Land assumed to be flat terrain (no topographical screening).

**Calculation Basis:**  
 Worst-case outline based on 2° solar elevation angle. This represents the maximum theoretical reach of flicker shadows (~4.3 km). Includes north-facing sector (300°-60° azimuth) and midsummer downwind lobes (120°-150° SE and 210°-240° SW).

No meteorological, operational, or real-world screening has been applied (e.g., cloud cover, wind orientation, turbine shut-down control). This is a geometric worst-case, not a prediction of actual exposure.

**Union Boundary**  
 The outer boundary shown is the union of all turbine flicker zones for the worst-case scenario. Represents the maximum extent of potential flicker effect from all turbines combined. Inner overlaps between turbines are not shown separately — outline is the maximum footprint.

**Prevailing Wind Consideration**  
 Dominant SW winds were considered in identifying most-likely sub-sectors (off-noon NE exposures). These are included in background calculations but the drawing depicts the full worst-case union.

**Usage Disclaimer**  
 Outlines are for planning and scoping purposes only. Actual shadow flicker duration and frequency will be substantially less due to:  
 - Limited sunshine hours in Ireland.  
 - Cloud cover and atmospheric conditions.  
 - Turbine yaw orientation varying with wind direction.  
 - Shut-down controls / curtailment policies where applied.  
 - Obstacles such as vegetation and buildings.  
 This drawing does not indicate guaranteed flicker exposure at every location inside the outline — only the maximum theoretical footprint.

**References**  
 Assessment aligns with Irish and EU shadow flicker guidelines (10 x rotor diameter or 1.5 km screening distance, whichever greater).  
 Conservative extension made to 2° elevation to illustrate outer theoretical envelope.

Issue:	Information
Project:	Ballinlee Green Energy Proposal Camass South/Ballinlee, Bruff, Co. Limerick.
Client:	BDAB Community Action Group
Drawing Title:	Aerial Photo Layout Turbine Locations and 500m, 640m Boundaries & Flicker Cover.

Drawn:	Scale at A1:	Checked:	Date:
RDL	1:10000	N/A	July 25

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Project No.	Drawing No.	Revision
250730	M02	0

