Liverpool Range Wind Farm

Fact Sheet
03
October 2021

Shadow Flicker Fact Sheet

Why was the assessment undertaken?

Shadow flicker results from the fluctuating light levels caused by intermittent (moving or changing) shadows and occurs when the sun passes behind the rotating blades of a wind turbine. This effect casts an intermittent shadow on the land and structures surrounding the wind turbine. Shadow flicker can cause annoyance when the shadow is received at a residence over an extended period of time.

A Shadow Flicker Assessment (SFA) was prepared by WSP Pty Ltd to assess the potential shadow flicker impacts associated with the following key changes to the approved wind farm layout and design proposed by the Modified Project:

- Increase in maximum blade tip height to 250 metres (m) above ground level (AGL) (increase of 85 m)
- Decrease in maximum number of turbines to 223 (removal of 44 wind turbines)
- Revised turbine layout and associated ground elevations

The SFA also undertook a comparative analysis of the Approved Project and the Modified Project and assessed the change in potential shadow flicker impacts between the two projects.

Blade glint can be produced by the reflection of the sun's light from smooth and reflective surfaces. Modern wind turbine blades are typically coated with non-reflective paint, to prevent the occurrence of blade glint. As such, no further assessment of blade glint has been undertaken.

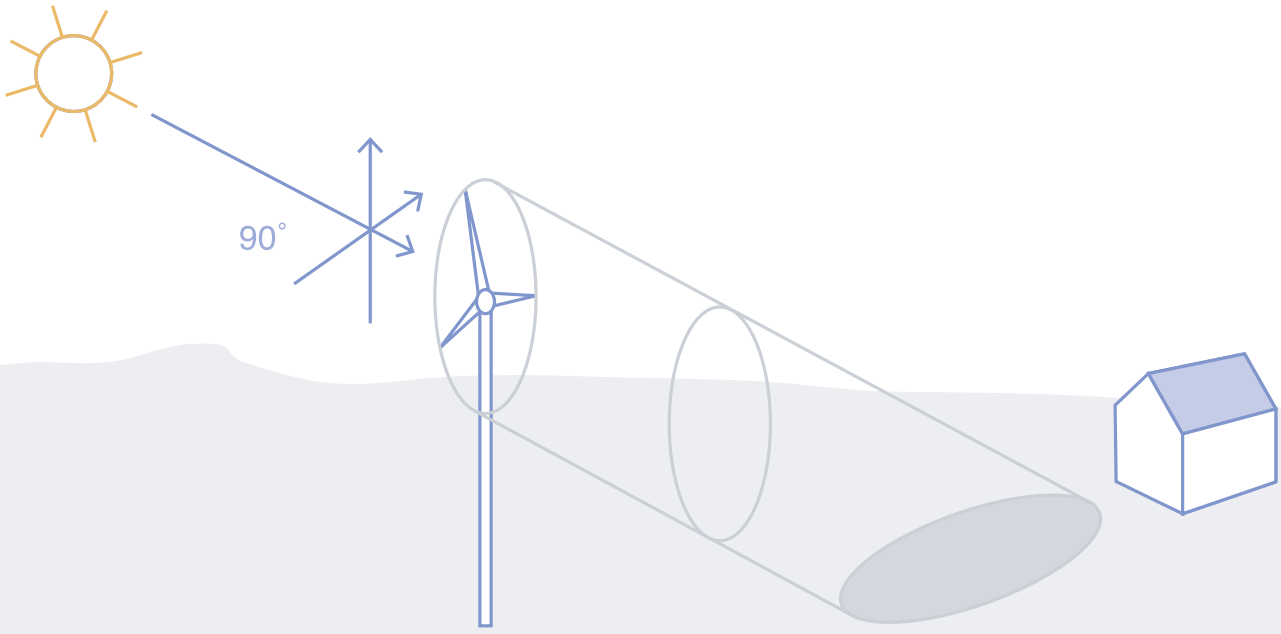


Diagram: Example of shadow flicker impacts for a WTG oriented directly facing the sun.

What was the methodology used?

The SFA was prepared considering the relevant conditions of Development Consent SSD 6696 and in accordance with relevant guidelines, legislation, and industry best-practice assessment methods, including:

- *Draft National Wind Farm Development Guidelines* (EPHC, 2010), and
- *NSW Wind Energy Visual Assessment Bulletin* (DPE, 2016b)

Development Consent SSD 6696 requires that shadow flicker from wind turbines does not exceed 30 hours per year at any non-associated residence. In accordance with the Draft National Wind Farm Development Guidelines shadow flicker effects were assessed out to 265 x times the maximum blade chord of the wind turbine blade (i.e. the thickest part of the blade where it attaches to the turbine hub), otherwise termed the 'shadow flicker assessment distance'. To model a conservative worst-case scenario a blade chord of 5.5 m was assumed, which equates to a shadow flicker assessment distance of 1,458 m from each wind turbine.

Shadow flicker (theoretical and a realistic scenarios) was assessed at all residences within the assessment distance from each wind turbine, and for the maximum duration shadow flicker occurring within 50 m of each residence. This approach is in accordance with the Draft National Guidelines and is intended to provide additional conservatism to the model, and ensure outdoor amenity around the residence is maintained.

Theoretical Shadow Flicker Scenario

The theoretical shadow flicker impact scenario does not consider any reduction in the extent of shadow flicker due to cloud cover, turbine rotor orientation, low wind speed, existing vegetation, or other shielding effects around each residence. This was to generate a conservative worst-case shadow flicker impact scenario that will likely exceed the actual shadow flicker impacts of the operational wind farm.

The Draft National Wind Farm Guidelines recommend that theoretical shadow flicker does not exceed 30 hours per year.

Realistic Shadow Flicker Scenario

The realistic shadow flicker impact scenario applies reduction factors to the theoretical worst case scenario shadow flicker model, in an attempt to predict the actual shadow flicker experienced at nearby residences. The reduction factors relate to cloud cover and wind speed, both of which influence the duration of shadow flicker that can potentially be experienced at nearby residences. As such, the realistic shadow flicker model incorporates the long-term average hours of sunlight from the nearby Wellington Rural weather station operated by the Bureau of Meteorology. It also incorporates ERA5 wind speed data which is a mathematical climate reanalysis model that uses ground-based and satellite-based observations as inputs to numerical weather models.

The Draft National Wind Farm Guidelines recommend that actual shadow flicker does not exceed 10 hours per year.

It is important to note that neither the theoretical or realistic shadow flicker scenarios consider potential screening effects from surrounding vegetation, building structures or outbuildings and as such, are considered to have additional conservatism built into the models. Actual shadow flicker impacts are likely to be further reduced for residences where existing screening is present.

What did we find and how does it compare to the Approved Project?

The theoretical worst case scenario modelling of the Modified Project found that a total of six (6) residences will receive shadow flicker, four (4) of which were modelled to receive shadow flicker in excess of 30 hours per year. All residences modelled to receive shadow flicker are associated landholders. No non-associated residences are modelled to receive shadow flicker in excess of 30 hours per year, using the theoretical case scenario modelling.

The realistic case scenario modelling of the Modified Project found that a total of six (6) residences will receive shadow flicker, four (4) of which will receive shadow flicker in excess of 10 hours per year, which is the recommended limit for realistic case scenario modelling from the Draft National Wind Farm Guidelines. No non-associated residences are modelled to receive shadow flicker using the realistic case scenario modelling.

Predicted theoretical shadow flicker within 50m of residence	Approved Project	Modified Project	Extent of Change
0-30 hours/year	No residences	2 residences (D4-7 & D4-8) – all are associated residences	Increase in 2 residences – all are associated residences
In excess of 30 hours/year	No residences	4 residences (D4-4, E4-2, E4-3 & E4-1) – all are associated residences	Increase in 4 residences – all are associated residences

What are the proposed mitigation strategies?

While not strictly required for the Modified Project as shadow flicker is not expected to exceed 30 hours/year at any non-associated residence, various mitigation measures can be considered to reduce shadow flicker impacts at nearby residences, such as:

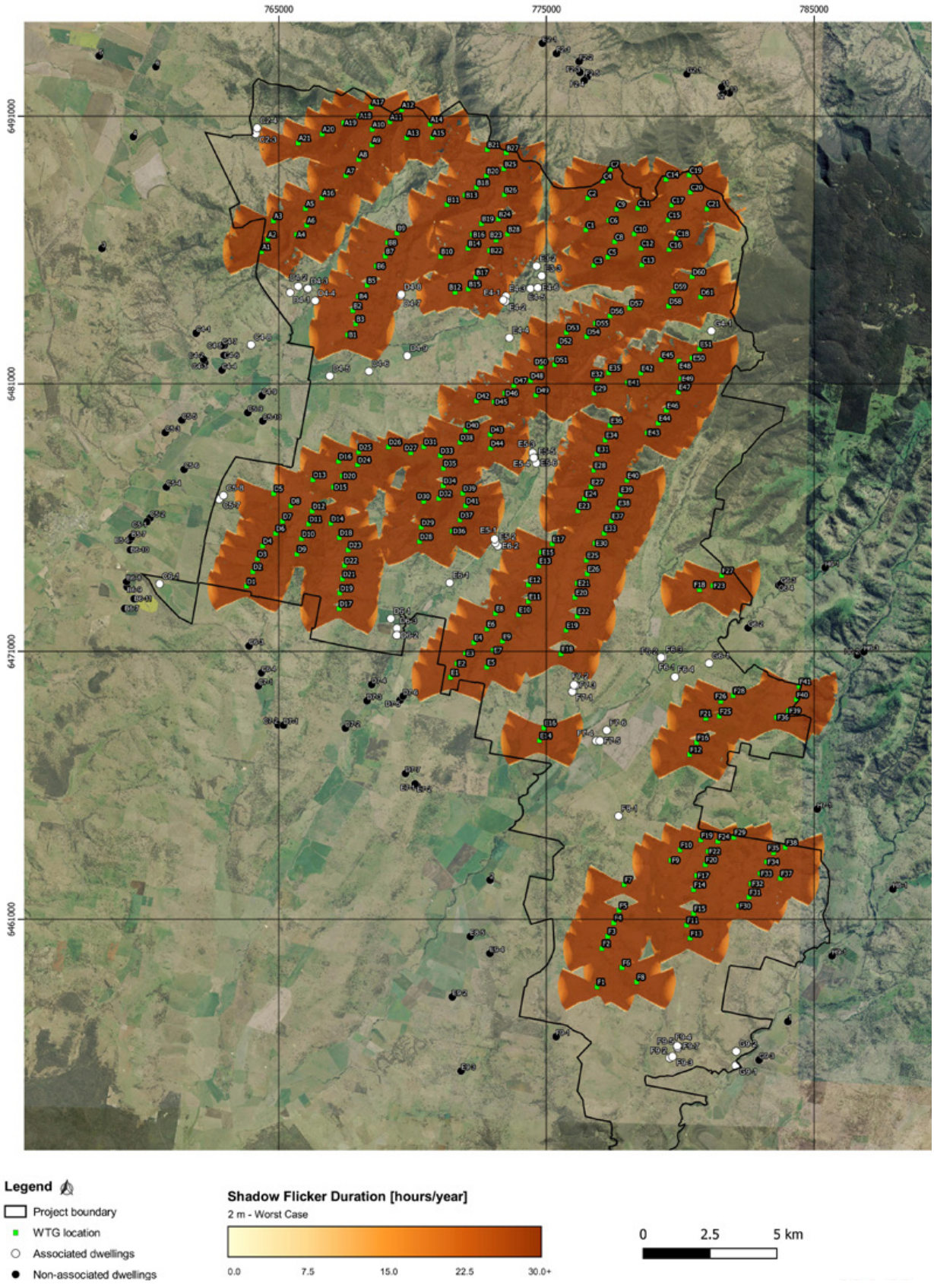
- Installation of screening structures or planting of trees to block shadows cast by the rotating wind turbine blades
- Use of wind turbine control strategies which shut down wind turbines when shadow flicker is likely to occur
- Micro-siting wind turbines to reduce impacts

In addition, a non-reflective finish will be applied to the wind turbine blades to ensure the potential effects of blade glint are reduced.

Assessment against Development Consent

The Modified Project can comply with the existing conditions of the Development Consent relating to shadow flicker and blade glint, in particular:

- Shadow flicker is not expected to exceed 30 hours per year at any non-associated residence
- The wind turbine blades will be coated in a non-reflective finish that minimises the potential for glare and reflection



Shadow flicker theoretical worst-case Scenario at 2 m height

For more information, please visit the website below
or call us anytime to ask questions using: **1800 WE TILT (938 458)**
Email: liverpoolrangewindfarm@tiltrenewables.com | **Web:** www.liverpoolrangewindfarm.com.au
Postal Address: PO Box 16080 Collins St West , Melbourne Vic 8007