



Cush Wind Farm
Phase II

Annex 13.4: Planning-Stage Shadow Flicker Monitoring Plan

Cush Wind Limited

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1.0 INTRODUCTION

This Planning-Stage Shadow Flicker Monitoring Plan has been prepared to establish the procedures and protocols for monitoring the effectiveness of wind turbine shutdown measures to prevent shadow flicker attributable to Cush Wind Farm – Phase II at receptors (dwellings, places of work and schools) in the vicinity of the project.

The proposed wind farm is located in rural County Offaly, approximately 4km north of Birr and c.28km southwest of Tullamore. The project comprises a three-turbine extension to the permitted Cush Wind Farm – Phase I, together with associated infrastructure, an electrical switch room, a c.5km underground electricity line, and turbine haul route accommodation works.

Chapter 13 of the Environmental Impact Assessment Report (EIAR) assesses the potential for shadow flicker at receptors within 10 times the maximum overall turbine tip height, equivalent to 2,000m. The assessment considers the proposed turbine dimension range and cumulative effects with other relevant wind energy developments. This Plan sets out the monitoring arrangements to verify the effectiveness of the automated shutdown measures implemented for Phase II.

1.1 PURPOSE OF THIS REPORT

Where shadow flicker could potentially occur at dwellings, places of work or schools; developers are required to provide calculations to quantify the likely effect and, where appropriate, take measures to prevent the occurrence of shadow flicker by turning off a particular turbine at certain times.

Chapter 13 of the Environmental Impact Assessment Report (EIAR) provides an assessment of the likely significant impact of shadow flicker on all of the identified receptors within 10-times the overall tip height of a wind turbine. Two separate scenarios are examined - the first provides 'expected' hours per year of shadow flicker and the second provides the 'worst-case' minutes per day of shadow flicker.

For Cush Wind Farm – Phase II in isolation, under the 'worst-case' scenario, 54 no. receptors are predicted to experience shadow flicker, with maximum daily durations ranging between 14 minutes and 1 hour 25 minutes. Under the 'expected' scenario, the same 54 no. receptors are predicted to experience shadow flicker, with annual durations ranging between 18 minutes and 12 hours 32 minutes. These results represent unmitigated model predictions; automated turbine shutdown measures will be implemented to prevent shadow flicker attributable to Phase II at receptors.

Monitoring of shadow flicker will be undertaken to verify the efficacy of the measures. The purpose of this Planning-Stage Shadow Flicker Monitoring Plan is, therefore, to set out the procedures for collecting the relevant data; the form that the relevant data will take; frequency that the data will be submitted to Offaly County Council ('the Planning Authority'); and details of contact persons for dealing with any issues in respect of shadow flicker.

It should be noted that this Planning-Stage Shadow Flickering Monitoring Plan is a draft document only and will be subject to further post-consent agreement with the Planning Authority, as necessary.

2.0 ROLES & RESPONSIBILITIES

2.1 CUSH WIND LIMITED

Cush Wind Limited will be responsible for procuring and contracting a suitably qualified shadow flicker consultant to carry out the post-construction shadow flicker monitoring regime.

2.2 SHADOW FLICKER CONSULTANT

The Shadow Flicker Consultant, to be appointed by Cush Wind Limited, will be responsible for verifying the application and implementation of this programme and associated procedures, supervision of the implementation of all agreed corrective measures, and for updating the programme when necessary. The Shadow Flicker Consultant will be suitably trained and qualified with respect to the environmental construction aspects of the project.

3.0 MONITORING PLAN

3.1 MONITORING

The final turbine model will be selected within the assessed dimension range, comprising rotor diameters of 158m–175m, hub heights of 111.6m–120.9m and overall blade-tip heights of 199.1m–200m. Irrespective of the final model selected, each Phase II turbine will be equipped with an automated shadow flicker control system, compatible with that turbine, to prevent shadow flicker attributable to the project at dwellings, places of work and schools.

Annex A provides a manufacturer's description of the Vestas Shadow Flicker Control System as an illustrative example of this technology. Its inclusion does not prescribe the turbine manufacturer or model. The system ultimately installed will provide equivalent shadow flicker prevention through automated turbine shutdown, using the predicted periods of potential shadow flicker and sunlight conditions to determine when shutdown is required.

Prior to commissioning, the control system will be configured for the final turbine dimensions, turbine and receptor coordinates, and the site-specific shadow flicker predictions. Shutdown schedules will incorporate sufficient allowance for the turbine stopping time to prevent shadow flicker occurring. The system will record shutdown events and relevant operating and sensor data, with its effectiveness verified through the monitoring and ground-truthing procedures set out below. These controls will remain in place throughout the operation phase.

3.2 GROUND TRUTHING

As part of the monitoring plan, site visits will also be carried out by a specialist consultant during the first 12-months of operation at times where shadow flicker has the potential to occur in order to ground-truth actual conditions. This will ensure the accuracy and validity of the turbine shut down procedures and provide opportunities for any refinement, as necessary.

3.3 MONITORING PROGRAMME

Shadow flicker monitoring will commence immediately upon commissioning of the wind turbines. The duration of the shadow flicker monitoring will be 12-months to allow for the consideration of all seasonal conditions. However, data will also be collected continuously throughout the proposed 35-year lifetime of the planning permission. In the event of a complaint from any third party, the data can be used to investigate the complaint and to make any modifications to the parameters for turbine sensor triggered curtailment mitigation, as are necessary.

3.4 DATA COLLECTION

The following data, at a minimum, will be recorded from the sensor module:-

- The date, time, location (turbine ID) and duration of the measurement;
- Sunlight intensity and direction;
- Wind speed and direction/rotor angle; and
- Time, date and duration of any sensor triggered curtailment.

In addition to the data produced by the sensor module, ground-truthing reports by the specialist appointed consultants will also be recorded. Information will also be logged in respect of any complaints received from third parties, follow up investigations and any required revisions made to the protocols.

3.5 MONITORING RECORDS

All shadow flicker monitoring data and records will be held in a dedicated file and will be made available to the Planning Authority, upon request, throughout the entire lifetime of the project.

A copy of the full monitoring survey to be undertaken within 12-months following the commissioning of the project will be provided to the Planning Authority in accordance with any relevant condition of consent.

4.0 CONTACT DETAILS

The owner can be contacted via the project website. Additional contact information will also be furnished to the Planning Authority in due course and will be provided on the project website.

ANNEX A – SHADOW FLICKER MODULE (ILLUSTRATIVE EXAMPLE)

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VestasOnline[®] Business

Vestas Shadow Flicker Control System

General Description

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1 Introduction

Environmental Control are optional modules for the VestasOnline® Business and VestasOnline® Compact SCADA systems.

The Environmental control suite of functions assist the power plant and its owners in protecting the environment from undesired side effects of the rotation from wind turbine blades.

This document provides a high-level description of the VestasOnline® Environmental Control option: Vestas Shadow Flicker Control System.

1.1 Abbreviations List

Abbreviation	Explanation
PPC	Power Plant Controller
VOB	VestasOnline® Business
VOC	VestasOnline® Compact
VSFC	Vestas Shadow Flicker Control
WTG	Wind Turbine Generator

2 Vestas Shadow Flicker Control System overview

Vestas Shadow Flicker Control (VSFC) system is an optional module that aims to prevent shadow flicker by WTGs on receptors close to the power plant.

Receptors are typically residents, offices, hospital and similar building structures.

Shadow flicker occurs when the position of the sun is at a certain level such that the sun rays pass in between the WTGs blades before hitting the receptor. This results in a light flicker effect which can be an annoyance and in worse case can result in photosensitive epileptic seizures.

VSFC is achieved by defining several schedules and rule sets that automatically pause the WTG when configurable environmental conditions are fulfilled. These conditions vary during the year due to the dependency of the sun position.

Environmental conditions that are taken into consideration by the VSFC system functionality are:

- Sun position relative to the WTGs and receptors.
- Distance between WTG and receptors
- Light intensity e.g during clouded days there will not be a shadow.

Multiple light intensity sensors might be needed depending on the layout of the power plant and numbers of receptors being affected. This is accomplished during the siting process.

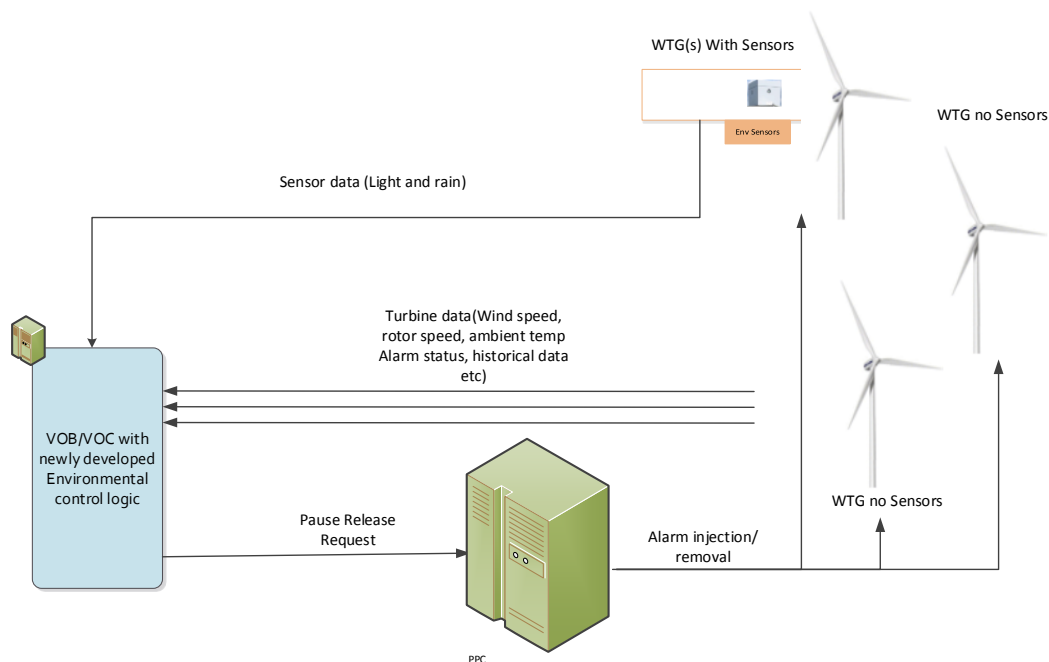
The VSFC functionality gives the users possibility to assign schedules and rules to individual wind turbines. Examples of rules include daily or yearly cumulative shadowing allowances on specific immission points, as permitted in certain building permits.

The customer is responsible for providing accurate GPS coordinates for the correct configuration of the system. Onsite validation to confirm accuracy of GPS coordinates is not included by default in Vestas scope.

The VSFC functionality is based on analytics logic residing on the VOB or VOC. The analytics logic calculates the possibility of shadow flicker on the predefined receptor and, in case a positive result is calculated, it will request the turbine to pitch the blades out of operation and pause the WTG.

The VSFC also comes with a user interface for monitoring as well as a function for generating reports exported via VestasOnline for audit purpose and production loss calculations.

3 System architecture



3.1 Environmental control logic

The environmental control logic is implemented to run on the VOB or VOC systems as software module. The module relies on OPC connectivity for collection of data and command interface towards the PPC and the VOB database is used for reporting purpose.

The following main functions are used/provided by the module.

Data collection: Data is collected from the turbine controllers and from sensors mounted on the turbines. Sensor values as well as sensor health status are logged with a timestamp.

Environmental control logic: The environmental control logic compares configuration data with the measurements from the sensors and turbine data. Based on the configured rules the logic evaluates the needed actions to be taken by the turbines.

Environmental logic output: The actions to be taken by the turbines are sent to the Power Plant Controller (PPC) for prioritization and execution of WTG control commands. This ensure that the WTGs do not receive multiple commands which might be conflicting. The PPC coordinates inputs from various systems including the Shadow Flicker Control system and ensures the plant is controlled in a way

Vestas

that reduces shadow flicker on receptors close to the power plant while respecting other priorities like grid code compliance.

All actions are logged and can be presented in reports.

All actions and sensor data instructing those actions, as well as sensor health status, are logged with a timestamp and can be presented in reports. If a sensor reports damage or lack of functionality, the system utilizes a default value to ensure curtailment when the other criteria are fulfilled.

User interface:

The user interface to the environmental control features contains the following main functionalities:

Monitoring	Supplies the user with information and status on the systems actuals.
Reporting	Supplies the user with an interface for generating reports. Audit reports and production loss reports.
Report types	Audit reports with information on decisions made, sensor data, sensor health configuration changes etc.
Report types	Production loss reports

3.2 Sensors

All sensors will be turbine based and consist of the following sensor types:

Sensor type	Amount needed
Light intensity	Depending on site layout

Sensor data will be based on current values from the sensors implying that they are “real time”, and not based on historical 10 minutes values.

Averaging, hysteresis and thresholds are used to ensure that spikes in the measured data do not result in the continuous pausing and releasing of the turbines. These settings can be modified in the configuration.

4 Compatible Systems

The Shadow Flicker Control System can be implemented on Vestas Power Plants fulfilling the following system requirements:

- VMPGlobal - WTGs with sensors and WTGs with alarm injection
- VestasOnline® Business Mk5/ VestasOnline® Compact Mk4.2 with software version 3.24 and later
- VestasOnline® Power Plant Controller Mk5 with software version 5.1.0 and later
- VestasOnline® Power Plant Controller Mk4 with software version 3.3.0 and later

5 Documentation

A configuration and user interface manual is part of the Shadow Flicker Control option.