Cush Wind Farm

Environmental Impact Assessment Report

Annex 12.4: Outline Shadow Flicker Monitoring Programme

Cush Wind Limited

Galetech Energy Services

Clondargan, Stradone, Co. Cavan Ireland

Telephone +353 49 555 5050

www.galetechenergy.com

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1.0 Introduction

This Outline Shadow Flicker Monitoring Programme has been prepared to establish the operational procedures and protocols to be followed in relation to the monitoring of potential shadow flicker on dwellings in the vicinity of the Cush Wind Farm.

The proposed wind farm site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. The project comprises 8 no. wind turbines and all other associated ancillary infrastructure.

A total of 106 no. dwellings are identified as being within 10-times the overall tip height (2,000m) of a wind turbine and have been assessed for potential impacts from shadow flicker in accordance with the *Wind Energy Development Guidelines for Planning Authorities 2006*.

1.1 Purpose of this Report

The probability of shadow flicker from a wind turbine causing a nuisance is extremely low. The Wind Energy Development Guidelines for Planning Authorities 2006 state that *"It is recommended that shadow flicker at neighbouring offices and dwellings within 500m* [of a wind turbine] *should not exceed 30 hours per year or 30 minutes per day"* (p.33). For the project, no dwellings are located within 500m of a turbine. It is further stated in the 2006 Guidelines that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low. Where shadow flicker could potentially be a problem, developers are required to provide calculations to quantify the likely effect and, where appropriate, take measures to prevent or ameliorate the potential effect, such as by turning off (curtailing) a particular turbine at certain times.

Chapter 12 of the Environmental Impact Assessment Report (EIAR) provides an assessment of the likely significant impact of shadow flicker on all of the identified 106 no. dwellings 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 the 'expected' hours per year, which is a realistic prediction of likely impact, none of the 106 no. dwellings are predicted to exceed the 30 hours per year limit. For the 'worst-case' minutes per day prediction, a highly conservative and improbable estimation, 23 no. dwellings could theoretically exceed the guideline limit of 30 minutes per day.

The purpose of this Outline Shadow Flicker Monitoring Programme is 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 the Planning Authority; and details of contact persons for dealing with any issues in respect of shadow flicker.

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

1.2 Roles & Responsibility

1.2.1 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.

1.2.2 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.

1.3 Shadow Flicker Monitoring Programme

1.3.1 Monitoring

A detailed description of the sunlight and shadow flicker shut down technology utilised by Vestas[1] is provided at **Annex A**. Shadow flicker shut down is a function that is integrated into the control system of the wind turbines and is specifically activated where shut down due to shadow flicker is necessary.

The technology is based on software that computes three factors: the position of the sun, the distance of the wind turbine to any potentially affected properties, and the sunlight intensity. The light sensor to be installed at the Cush Wind Farm will measure the intensity of the sun's visible radiation. Using the results, the module determines whether the intensity of the visible direct sun radiation is capable of causing shadow impact. At the same time, the shadow impact module calculates whether shadow impact occurs in a place of immission i.e. at a sensitive receptor based on a predetermined set of times.

In case the intensity of the direct sun radiation is capable of causing shadow impact and shadow impact is detected in a place of immission, the counters for daily shadow impact are updated in cycles of 1 minute. If one of the limit value parameters set is exceeded (i.e. 30 minutes per day or 30 hours per year) in this place of immission, the sensor triggers the wind turbine responsible to automatically shut down for the duration of the shadow impact. As the calculations require the exact time, the shadow impact module is equipped with a radio controlled clock.

The data collected by the sensor module will be relayed offsite to the Cush Wind Farm's Supervisory Control and Data Acquisition (SCADA) system. This is a computer system which manages all of the data acquisition and control of all aspects of the wind turbines. This information will be stored within the SCADA system for analysis and presentation to the Planning Authority, as required.

The implementation of this software will allow the wind farm owner to remotely curtail the operation of the turbines, thereby ensuring that instances of shadow flicker do not exceed 30 minutes per day or 30 hours per year at any dwelling.

1.3.2 Ground Truthing

As part of the monitoring programme, 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 at sensitive receptors. This will ensure the accuracy and validity of the curtailment mitigation measures and provide opportunities for any refinement, as necessary.

1.3.3 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

[1] The turbine selected for the project is the Vestas V172 (see **Volume I, Chapter 3** for further details).

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.

1.3.4 Data Collection

The following data, at a minimum, will be recorded from each 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.

1.3.5 Monitoring Records

All shadow flicker monitoring data and records will be held in a dedicated file and will be made available to Monaghan County Council, upon request, throughout the entire lifetime of the planning permission.

A copy of the full monitoring survey to be undertaken following commissioning of the wind turbines will be provided to the Planning Authority in accordance with any relevant condition of consent. This report will include all of the data collected in **Section 1.3.4** above.

1.4 Contact Details

The owner of the wind farm will be responsible for procuring and contracting a suitably qualified consultant to carry out the shadow flicker monitoring programme. The owner can be contacted via the Cush Wind Farm website (www.cushwindfarm.ie). Additional contact information will also be furnished to the Planning Authority and will be provided on the project website.

Annex A –
Shadow Flicker Control System

Restricted
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VestasOnline® Business

Vestas Shadow Flicker Control System

General Description

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Denmark · www.vestas.com

Table of contents

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.

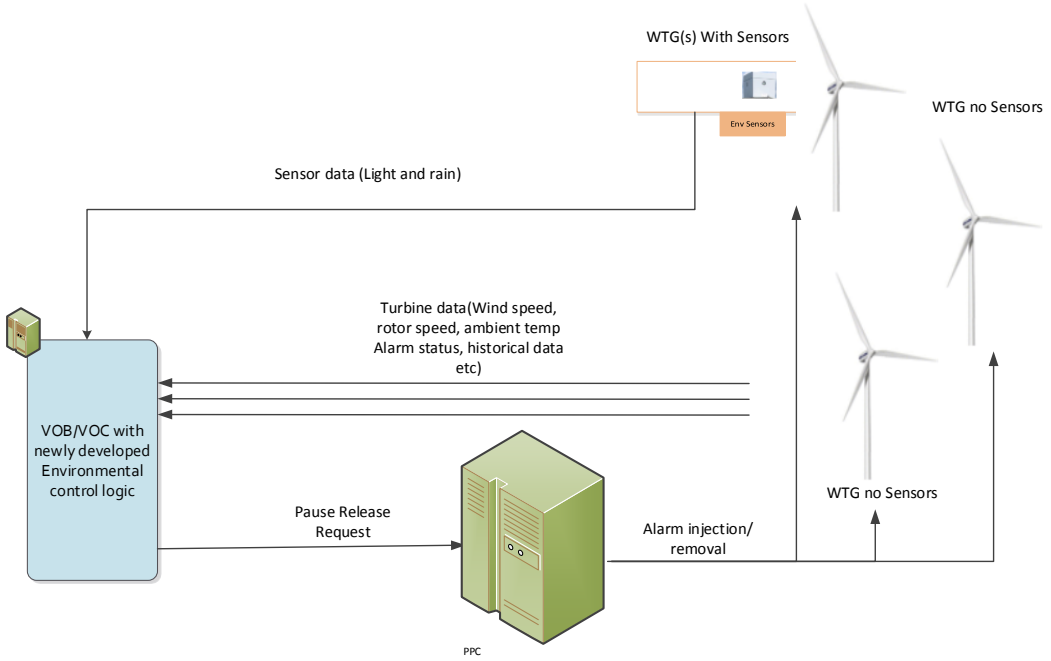
The VSFC functionality gives the users possibility to assign schedules and rules to individual wind turbines. Examples of rules include daily or yearly cumulative shadowing allowances on specific immission points, as permitted in certain building permits.

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

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 setting 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.