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# VestasOnline<sup>®</sup> Business

## Vestas Shadow Flicker Control System

### General Description

Table of contents

1 Introduction..... 3

1.1 Abbreviations List ..... 3

2 Vestas Shadow Flicker Control System overview ..... 3

3 Curtailment criteria ..... 4

4 System architecture..... 4

4.1 Environmental control logic ..... 5

4.2 User Interface ..... 5

4.3 Sensors ..... 5

5 Compatible Systems..... 6

6 Documentation..... 6

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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 Vestas Shadow Flicker Control System.

### 1.1 Abbreviations List

Abbreviation	Explanation
PPC	Power Plant Controller
VOB	VestasOnline® Business
VOC	VestasOnline® Compact
WTG	Wind Turbine Generator
WPP	Wind Power Plant

## 2 Vestas Shadow Flicker Control System overview

Environmental Control Options are needed in many power plants in order to comply with local legislation and building permits. The Shadow Flicker Control System is implemented as a part of the overall Environmental Control solution and shares some components with other Environmental Control Options such as Bat Protection System.

The Shadow Flicker Control System module is designed to reduce shadow impact of rotating wind turbine blades (also known as ‘shadow flickering’). This is done by automatically pausing the wind turbines in time periods with shadow impact on buildings or recreational areas. One or more light sensors measure the intensity of the sunlight and in combination with a calculation of the position of the sun, the wind turbine(s) are curtailed (set in Pause state) when the conditions for shadow control are met.

In addition, the Shadow Flicker Control System module can also handle country-specific rules that allow flickering for a specified amount of time daily and yearly per building. This is also referred to as ‘Allowed Flicker’ rules.

Each turbine can have several nearby houses that it can cast flickering shadow upon and if the allowed flickering time for any of these houses has been used the Shadow Flicker Control System will issue a recommendation to pause the turbine.

The Shadow flicker control functionality also comes with a user interface for monitoring as well as a function for generating reports for audit purpose and production loss calculations.

**NOTE:** Vestas Online® Compact server storage capacity is limited to a single year of operational data. Data retention for Shadow flicker control Compliance reporting therefore cannot be guaranteed beyond 1 year.



### 3 Curtailment criteria

The Shadow flicker control User Interface allows the user to import external calendar files generated in windPRO to define the curtailment schedules for the individual wind turbines of the WPP regarding shadow flicker control.

The Shadow flicker control Interface also allows the user to map the wind turbine names included in the windPRO files and the wind turbine names defined in the wind farm to ensure the correct configuration of the system.

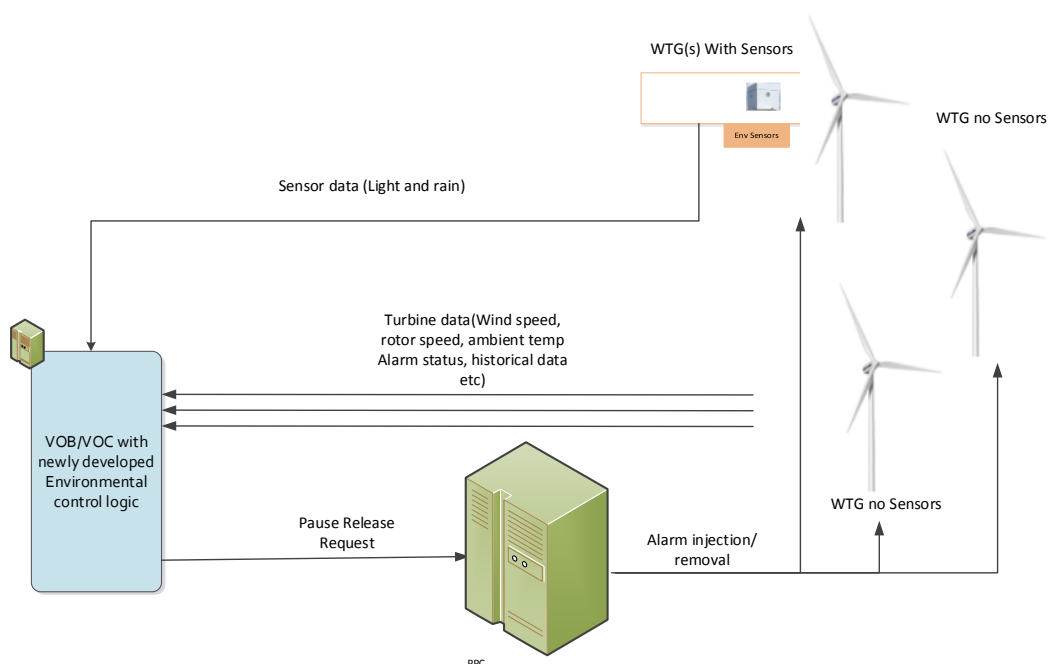
There are a total of three criteria evaluated for each configured building and each WTG to assess on the risk of shadow flickering:

- Date/Time (as per defined in the imported schedules in windPRO calendars)
- Light intensity measured in the configured light sensor (compared with the configured light intensity threshold value)
- Allowed flickering time available in each building (both daily and yearly)

On that regard:

- If ALL criteria fall within the configured exclusion range, the Shadow flicker control logic will curtail the WTG.
- If ANY of the criteria fall outside the configured exclusion range of the schedule, the Shadow flicker control logic will release the WTG.

### 4 System architecture



## 4.1 Environmental control logic

The environmental control logic is implemented to run on the VOB or VOC systems as software modules. The module relies on OPC connectivity for collection of data and command interface towards the PPC, while data is stored in the existing VOB database. This allows existing VOB database reporting functionality to be utilized.

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 WTG.

Environmental logic output: The actions to be taken by the WTG 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. All decisions are logged and can be presented in reports.

## 4.2 User Interface

The user interface contains the following main functionalities:

Monitoring: Information and status on the systems actuals and a command interface for users.

Reporting: Configuration and Performance Reports

Configuration: Configuration of the system variables

## 4.3 Sensors

Sensors utilized will consist of the following types:

Sensor type	Amount needed
Light intensity	Depending on site layout

**NOTE:** Shadow flicker may occur when the direct sunlight is above a predefined threshold. The level of direct sunlight is measured as the difference between the east and the west light sensor. In this way, turbines will not be curtailed in diffuse sun light conditions e.g., due to cloud coverage or fog.

## 5 Compatible Systems

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

- Onshore Vestas Turbine variants with VMP Global SW version 2019.05.xx or higher
- VestasOnline® Business Mk5/ VestasOnline® Compact Mk4.2 with software version 3.27 or higher
- VestasOnline® Power Plant Controller Mk5 with software version 5.1.0 or higher
- VestasOnline® Power Plant Controller Mk4 with software version 3.3.0 or higher

## 6 Documentation

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