

Features

- Supervisory control of each wind turbine generator
- Protective supervisory shutdown
- Programmed supervisory stop
- Operating status detail for every wind turbine generator
- Power curves for:
 - Documenting data
 - Optimizing machine performance
 - Facilitating scheduling blade cleaning service
- Identifies production potential
- Supervisory control of switch gear
- Economic dispatch
- Wind turbine generator maintenance management
- Wind turbine diagnostics and alarms



Wind is an infinitely renewable supply of power that can be harnessed as an outstanding energy source given the proper location and use of the latest turbine generation technology. Major power producers world-wide have adopted wind power, a clean source of energy that can last up to 20 years or more, as an economically viable alternative to fossil-fueled power generation.

Wind farms can fluctuate in size depending upon the availability and strength of their surrounding airstreams. Wind farms are beginning to increase in magnitude as utilities are starting to see the significant amount of electrical generating capacity that can be added to their overall production.

Within a farm, individual wind turbine generators are interconnected with a medium voltage collection system and communications network. This medium-voltage electricity is then stepped up with a transformer to a high voltage transmission system and the electric grid. As the

number of wind turbine generators increases within a farm's configuration, the need for managing those assets becomes progressively more important.

Emerson's Ovation SCADA solution can manage your wind farm generation resources to help minimize turbine generator downtime and maximize their availability. Based on the Ovation SCADA Communication Server, our solution features state-of-the-art control and diagnostic functions to optimize your wind farm operations.

Wind Turbine Control and Operation

Supervisory Control

Supervisory control of each wind turbine generator includes start, stop, reset, and tag out functions. An interactive wind farm overview graphic provides convenient operator access to these functions. This graphic can be customized to match the configuration of any wind farm.

Select any one of the wind turbine generator symbols within the display to access a graphic control window. This window contains built-in buttons that help the operator manually control the turbine through start, stop, and reset functions.

A tag out button is provided to place a turbine into maintenance mode. Permissive interlocks are built into this function for accomplishing this activity in a safe manner. A reset button clears the tag out condition once the maintenance has been completed.

The Ovation SCADA server control window also provides a means to send a speed set point to the wind turbine generator. This function can be used to activate a change in speed (faster or slower) to within a range specified by the turbine's original equipment manufacturer. While the control window offers these functions for manual operator intervention, the Ovation SCADA system is designed to accomplish many of these functions automatically.

The wind turbine generator symbol on the overview graphic changes color depending on the state of the selected turbine, as defined below:

Color	Turbine Operating Status
Red	Operating at maximum allowed speed
Yellow	Operation has stopped
Green	Operating at a speed between zero and maximum allowed
Orange	Protective supervisory shutdown has been activated and turbine has stopped operation

Protective Supervisory Shutdown

Protective supervisory shutdown is an inherent function in the Ovation SCADA solution that protects the wind turbine generator. This function is automatically performed by the Ovation SCADA Server when certain predefined site conditions are reached. For example, the direction and speed of wind on a farm can randomly change at any time. A typical wind farm configuration consists of rows and columns

of turbines that in some instances can be located close together. Strong winds that blow directly parallel to a row of turbines can potentially cause damaging vibrations to the turbine blades. Vibration conditions can be monitored through meteorological data obtained from a Met tower interface to the Ovation SCADA system. When the vibrations exceed a safe operating limit, the Ovation SCADA system activates a shutdown of the turbine to avoid any equipment or area damage.

Once a turbine is shutdown by the protective supervisory shutdown function, it can only be manually reset by the operator provided all of the adverse conditions that caused the shutdown have been restored.

Programmed Supervisory Stop

A programmed supervisory stop is similar to the supervisory shutdown function except that it is based on other conditions that may be present at a wind farm site that are not related to safety issues. For instance, depending on the direction and angle of the sunlight, the rotating blades of a wind turbine can sometimes have an adverse stroboscopic effect on humans looking at the rotating turbines. Consequently, in some wind farm locations, due to local regulations, one turbine or a group of turbines may have to be stopped at certain times of the day to alleviate the stroboscopic condition. The Ovation SCADA system allows the user to program supervisory stops to accommodate issues such as the stroboscopic effect caused by local conditions.

Another key difference between the supervisory stop and shutdown functions is that the user can choose to let the SCADA system automatically restart from a programmed stop or elect to use a manual start.

Turbine Operating Status Details

Operating status details for every wind turbine generator on a farm is provided through a small graphical block with the letter "S" appearing next to each turbine symbol on the overview graphic. Selecting this small block gives the user access to critical operating status details for the chosen individual turbine. Status details are provided based on data received from different SCADA

interfaces, such as the turbine generator controller, substation, and Met tower. Critical operating details can be provided for:

- General
 - Power Output
 - Wind Speed
 - Rotor speed
 - Generator speed
- Electrical
 - Voltage
 - Current
 - Reactive Power
 - Frequency
 - Power Factor
- Mechanical
 - Generator Temperature
 - Nacelle Temperature
 - Outside Temperature
 - Vibration 1,2,3, and 4
 - Pitch
 - Brake Activated
 - Yaw Activated

A blinking red “S” symbol indicates an alarm condition when any of the critical status parameter exceeds the specified limit for the selected turbine. The alarm generated by the Ovation system can be accessed through the Ovation alarm log. The blinking stops when the alarm condition has been cleared.

Power Curve

A wind turbine power curve is a graph that indicates how large the electrical power output will be for a turbine at different wind speeds. The power curve included with the Ovation SCADA solution can be used as a documentation tool, to optimize performance of the machine, and to facilitate the utility’s service department in determining intervals and requirements for blade cleaning. The power curve can be easily accessed through a button on the top bar of any process graphic.

Production Potential

The production potential of any wind farm depends on a number of factors, including wind speed, wind direction, condition of the turbine generator, and local regulations. Emerson’s Ovation SCADA solution provides a tool that

forecasts the production potential for a predefined time period based on the known state of such factors. This tool is presented in a graphic that plots the potential power output versus time. Production potential is also visible on the bottom bar of the wind farm overview graphic or from a button at the top of the overview graphic.

Supervisory Control of Switchgear

Supervisory control of the switchgear can be performed through the Ovation SCADA interface with the substation. While various protective switchgears automatically operate as designed, the Emerson SCADA interface allows for certain manual actions by the operator provided proper interlocks are satisfied. The supervisory control function is accessed through the substation overview graphic via a button on the top bar of any process graphic.

Economic Dispatch

As an option, economic dispatch can be provided with the Ovation SCADA system. Using modern advanced modeling techniques, this function can assist the owner by obtaining the best economic performance out of the wind farm to meet generation and financial needs.

Turbine Maintenance Management

Wind turbine generator maintenance management schedules and history are easily tracked through the Ovation SCADA historian capability and reporting tools. Custom reports can be created and easily accessed through a button on the top bar of any process graphic.

Wind Turbine Diagnostics and Alarms:

Diagnostic information available from the turbine original equipment manufacturer, the Met tower, and the substation, is also available in the Ovation SCADA system through network interfaces. A predetermined set of such information is shown on the operating status detail graphic for the farm’s turbine fleet.

Diagnostic information is stored in the Ovation Historian. The storage capacity of the Historian can be optionally tailored to the needs of the wind farm owner. The Ovation Historian provides tools for creating custom graphical

trends to monitor various equipment and conditions on the farm. The trends can be accessed from the buttons on the top bar provided on the wind farm overview graphic.

Process graphics also include a set of buttons located on the bottom bar for accessing the following important status information:

- Outside temperature
- Wind speed
- Wind direction
- Farm power output
- Percentage utilization of farm capacity
- Number of operating turbine clusters
- Production potential forecast

Alarm management is an inherent part of the Ovation SCADA system. Alarms can be programmed based on the operational needs of the wind farm. Ovation alarm management allows the user to define a number of priority levels to assist the operator in addressing high priority alarms first instead of getting overwhelmed by number of nuisance alarms. A listing of all alarms can be easily accessed through a button on the top bar of any process graphics.

A system status diagram on Ovation SCADA system shows the status of various hardware components of the Ovation SCADA system.

Sample Ovation Architecture for Wind Farm Energy Management

