Environmental Monitoring System for Photovoltaic Power Plant

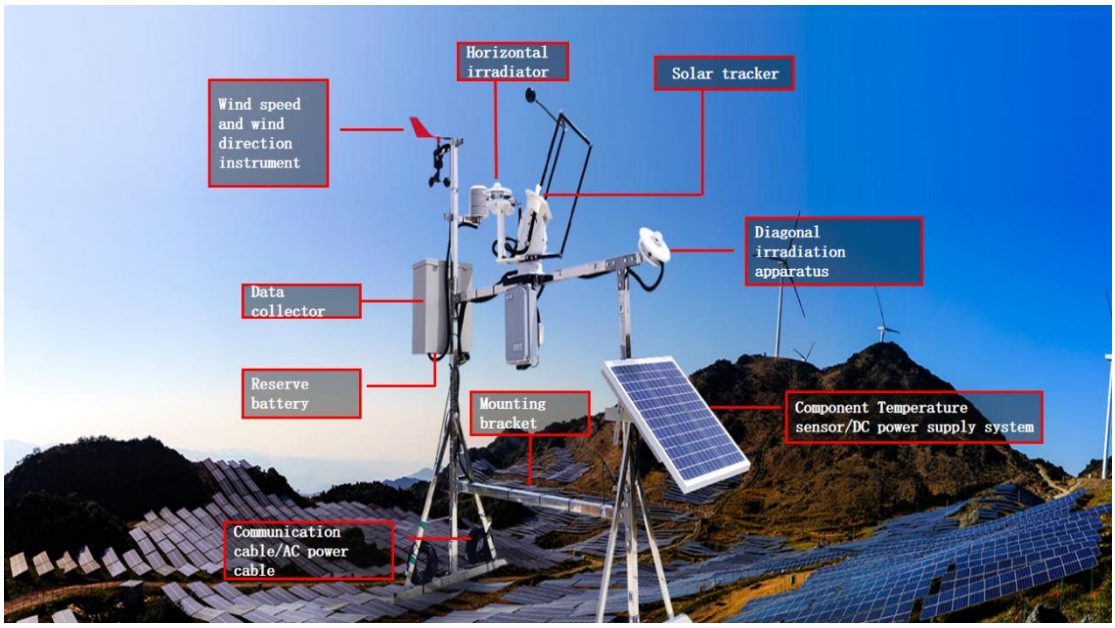
(SA-A-20210903-001)

The main factor affecting photovoltaic power generation is the weather conditions where the project is located, which is directly related to the investment and income of the project. Therefore, the performance evaluation of photovoltaic power plants is inseparable from accurate meteorological data and solar irradiance data.

The environmental monitoring system meteorology plays a very important role in the photovoltaic power station monitoring system. The accurate environmental weather measurement data is the key parameter of the photovoltaic power station tracking system, power generation forecasting and power control performance, so it is necessary in each photovoltaic power station monitoring system equipped with an environmental monitoring system.

1. The composition of the environmental monitoring system

The environmental monitoring system of photovoltaic power station is mainly composed of a variety of weather monitoring sensors and different types of solar radiation sensors. According to the International Meteorological Organization's Meteorological Observation Standards and IEC (International Electrotechnical Commission) and other norms and standards, photovoltaic power plants need to monitor nine types of standard weather data including the total radiation, scattered radiation, sunshine hours, direct radiation, wind speed, wind direction, pressure, ambient temperature, humidity and the backplane temperature of the module.



1.1 Irradiator:

The irradiator is used to measure a series of radiation intensity of the power station, and the response band of the irradiator should cover the band of the absorption spectrum of the PV module. Usually, multiple irradiators are used at the same time to monitor the irradiation at different installation angles. Photovoltaic power station irradiator mainly monitors total radiation, horizontal radiation, scattered radiation

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and sunshine time.

1.2 PV module temperature sensor:

The module temperature sensor is installed on the back of the photovoltaic module to monitor the temperature of the cells in the module. The measurement principle is to use a heat exchange model to convert the temperature of the back plate of the module to the temperature of the cell inside the module. The conversion process also needs to input the ambient temperature, wind speed, and wind direction for correction.

1.3 Ambient temperature and humidity sensor:

Environmental temperature and humidity sensors are used to monitor the air temperature and humidity around the actual operating site.

1.4 Air pressure sensor, wind speed, wind direction sensor and rain gauge:

Air pressure sensor, wind speed, wind direction sensor and rain gauge are used to monitor the parameters of atmospheric pressure, wind speed, wind direction and rainfall at the site. These parameters are related to power generation, but these elements are generally not used in power station performance evaluation.

1.5 Special bracket:

Special brackets are used to install various monitoring sensors. The support structure design needs to pay

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attention to the mutual influence of sensors, and cannot affect the accuracy of sensor data collection.

1.6 Sun tracker:

The sun tracker tracks the change parameters of the sun's illumination angle and provides parameters for the photovoltaic power station tracking bracket algorithm.

1.7 Data collector:

The data collector is to provide sensor measurement, time setting, data compression, data and program storage and control functions. Composed of a measurement control module and a distribution panel, it has powerful network communication capabilities.

CR1000 has the characteristics of high precision, high adaptability, high reliability and reasonable price, making it an ideal choice for scientific research, commercial and industrial system applications. At present, the CR1000 data collector has been widely used in many fields such as meteorological observation, agricultural research, soil moisture research, wind observation, road weather station, industrial product testing, flux observation, and eddy covariance system.

The standard CR1000 data collector contains 4M data and program storage space, and large-capacity data storage can be achieved through an external storage module and CF memory card. Data and programs are stored in non-frustrated flash memory and memory. The lithium battery is installed in the memory and real-time clock. When the battery (BPALK, PS100) voltage drops below 9.6V, CR1000 can also delay the execution of the operation, thereby reducing the possibility of inaccurate measurement. CR1000 can be expanded through peripheral equipment to form a data acquisition system. Multiple CR1000 systems can build a network to form a local or entire region monitoring network.

2. working principle of the environmental detector system

The photovoltaic power station environmental monitor adopts the modular design principle, which is mainly composed of a power supply module, a data processing module, a remote communication module, and a sensor access module.

The main function of the power module is to provide working power to the system; the remote communication module is to send and receive data and images; the sensor access module is to access the analog information of each sensor; the data processing module is responsible for the unified management of the system, including data collection/storage, analysis and statistics of meteorological data, system settings, local data display, data storage management and other functions.

The schematic diagram of the system composition is as follows:

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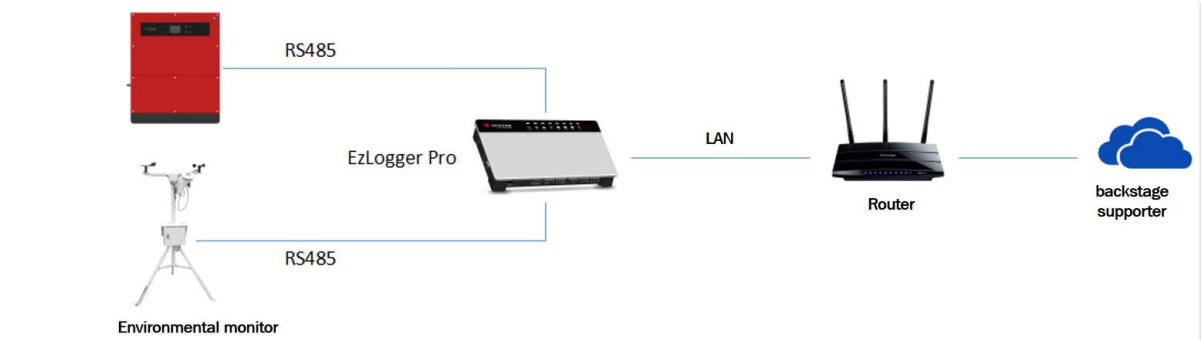
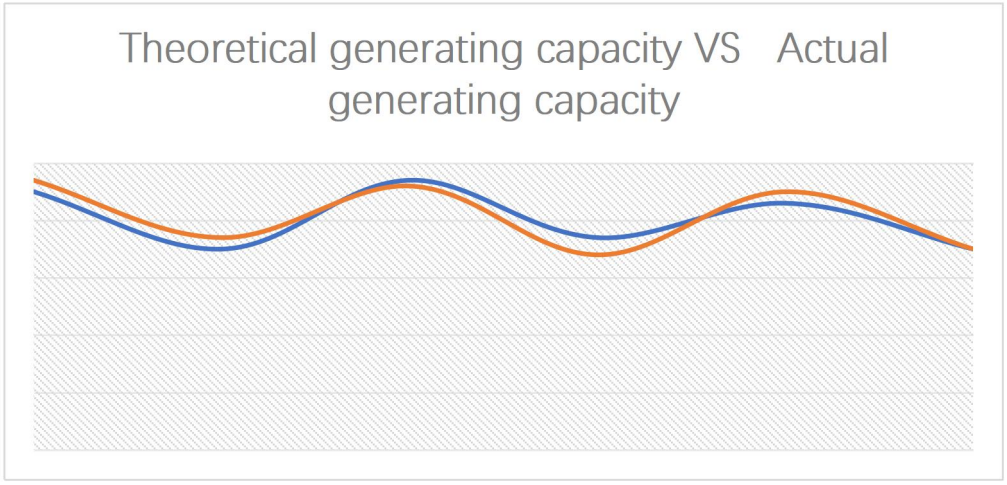


3. The role of environmental monitors on photovoltaic power plants

3.1 Real-time monitoring of local environmental changes, including irradiance, wind speed, wind direction, temperature and humidity, etc., and upload them to the background monitoring computer in real time. For photovoltaic power stations, the irradiance directly affects the power generation of the station. For wind power generation, wind speed and wind direction are directly influencing factors. The operation and maintenance personnel of the power station can calculate the power generation capacity of the day based on the total irradiance value and the capacity of the power station components.

3.2 Obtain weather information from the environmental monitor and send it to the optical power prediction system. The optical power forecasting system sends short-term forecast data, ultra-short-term forecast data, meteorological information and other data to the dispatch center through 102 communication protocol or FTP format, and then the dispatch center formulates a power generation plan based on the forecast data to balance various local energy generation indicators and pass AGC dynamically adjust the power generation.



4 the main technical indicators of the environmental monitor

The main technical parameters of environmental monitors are as follows:

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elements	Measuring range	resolution	precision
The environment temperature	-50～+80℃	0.1℃	±0.2℃
Relative humidity	0～100%	0.1%	±2%
The direction of the wind	0～360°	2.5°	±3°
The wind speed	0～75m/s	0.1m/s	±(0.3+0.03V)m/s
The component temperature	-40～150℃	0.1℃	±0.2℃
The atmospheric pressure	550～1060hPa	0.1hPa	±0.3hPa
Total radiation table	0～2000 W/m²	1 W/m²	≤5%
Sunshine time	0～24h	0.1h	±0.1h
Direct radiation	0～2000 W/m²	1 W/m²	≤2%
Scattered radiation	0～2000 W/m2	1 W/m²	≤5%

5 Application of environmental monitoring instrument in the operation and maintenance of photovoltaic power station

The operating status of the photovoltaic string has a direct impact on the power generation capacity of the power station. It is also an important function of the environmental monitor to troubleshoot the photovoltaic string through the data of the environmental monitor, and to cooperate with the tracking bracket to perform the operation and maintenance of the system.

Common faults in photovoltaic field are as follows:

Current mismatch in the string (blocking, dust, module current inconsistency)

Abnormal current output of the module (blocking, broken glass, hot spots)

Abnormal string voltage (diode short circuit, module failure)

String open circuit

The series and parallel resistance are too low (PID attenuation, dust)

The series resistance of the string is too high (the cable impedance is too high, the internal resistance of the module is abnormal)

String short-circuit current is low (abnormal orientation, dust, module attenuation)

5.1 IV diagnosis

The IV diagnostic feature is to use the string current and voltage data of the string inverter, according to the electrical characteristics of the photovoltaic module array, combined with the parameters of the environmental monitoring instrument (irradiation intensity and module backplane temperature) to check whether the module array is working properly rough judgment. If an abnormal situation occurs, an early warning is given. In the case of early warning, start the string IV scan to accurately classify the fault and realize the intelligent diagnosis function.

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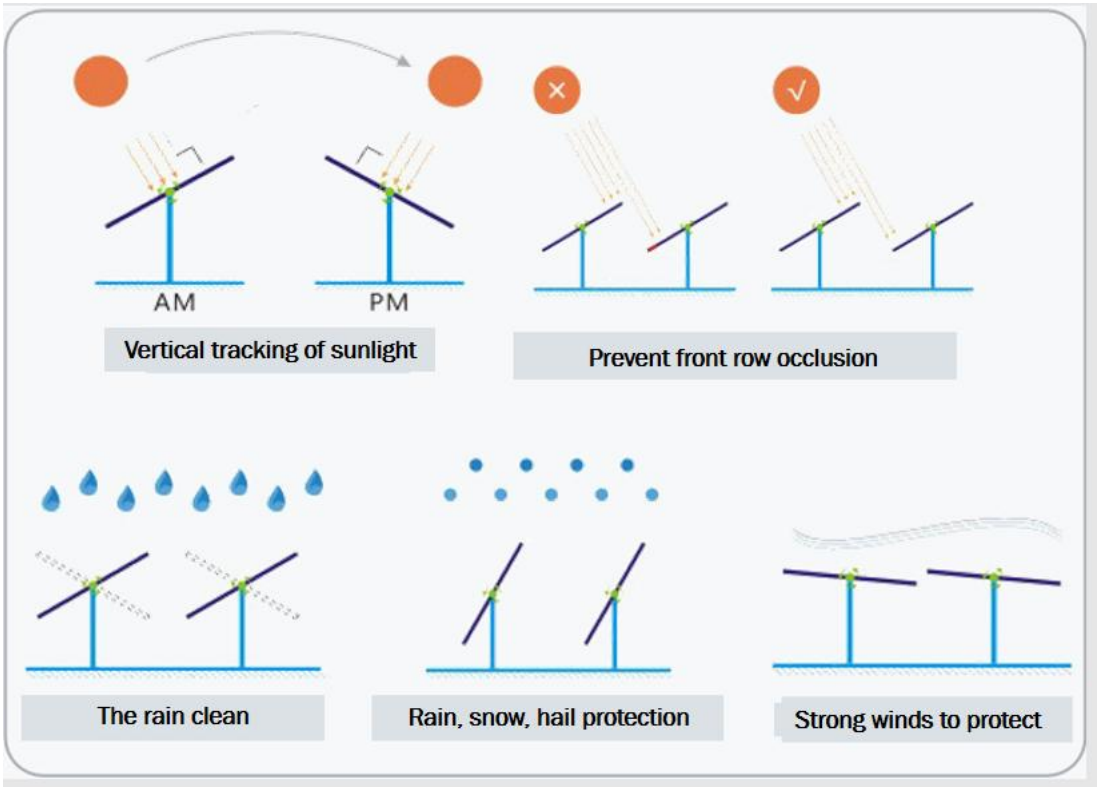
Using the intelligent diagnosis system, the faulty strings in the photovoltaic power station are screened out in time, and the relevant personnel of the power station are prompted to inspect, maintain and replace, so as to minimize the power generation loss of the power station.

5.2 Tracking system

Under normal circumstances, the environmental monitor provides the track system with logical algorithm data, so that the tracking bracket can track the maximum radiation in real time and ensure the yield of power generation. For photovoltaic fields with heavy sand, dust, rain and snow, preventive adjustment of the tracking bracket angle in advance according to meteorological data (wind speed, temperature, rainfall, etc.) to clean or protect the components.



6. the characteristics of environmental monitors

6.1 Flexible configuration

Different monitoring elements can be configured according to the different monitoring requirements of the power grid company, and the required meteorological elements can be monitored by adjusting different sensors.

6.2 Easy to install

Each sensor of the environmental monitor is modular in design, usually plug-in installation, the whole set of equipment is small in size, light in weight, and convenient in construction and installation.

6.3 Multiple communication methods

Most devices support standard communication interfaces such as RS232/MODBUS/RS485/USB to read data on-site with PDAs, laptops and other devices, and can also realize local long-distance data communication.

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Although the environmental monitor is a very small device in a large photovoltaic power station, it plays a very important role. It monitors the ambient temperature, wind speed, wind direction, irradiance and other meteorological data around the power station to determine the power generation capacity of the power station. Analysis and health diagnosis provide evaluation basis; through data analysis and timely forecast, it is convenient for operation and maintenance personnel to find and prevent problems in time.

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