

## **The Development and Application of a Training Base for the Installation and Adjustment of Photovoltaic Power Generation Systems**

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### *Abstract*

In recent years, the development and application of green energy resources have attracted more and more attention of people. The training room presented here is focused on the terminal applications of a photovoltaic power generation system (PPGS). Through introducing the composition and the general design principles, we aimed at leading the students to master the fundamental skills required for its design, installation and construction. The training room consists of numerous platforms, such as: PPGS, Wind and Photovoltaic Hybrid Power Generation Systems, Wind Power Generation Equipments, Simulative Grid-Connected Power Generation System, Electronic Technology Application of New Energy, etc. This enables the students to obtain their project and professional skills training via assembling, adjusting, maintaining and inspecting, etc., various component parts of the photovoltaic and new energy power generation systems, to further grasp the fundamental and related theoretical knowledge, and to further reinforce their practical and operational skills, so as to improve their problem-analyzing and problem-solving abilities.

**Keywords:** *Solar tracking;;wind-PV hybrid; distributed control; volt-ampere characteristic; steering tail rudder; off-grid inversion; grid-connected inversion*

### **1. INTRODUCTION**

Nowadays, since the global environment we live in is more and more deteriorated by environmental pollution and excessive emissions, the development and application of green energy sources have become important global goals. Green energy, also known as clean energy, is the symbol of environmental protection and of a good ecological system. Green energy mainly involves renewable energies such as solar energy, wind energy, hydropower, biomass, ocean energy, and so on<sup>[1]</sup>. Derived from nature, it seldom causes secondary pollutions of the environment during usage. Therefore, it not only protects the environment, but also helps to solve the challenge of energy shortage.

The training base for the installation and adjustment of PPGSs is focused on the terminal applications of a

photovoltaic and a wind-PV hybrid power generation system. The building of this training room should help the students of our vocational college to adapt to the associated social requirements and to reach their full potential in this field, to let them know hands-on the PPGS and the related equipments, understand the general principles used for the design of PPGSs, and master the fundamental skills required for the design, installation and construction of a PPGS. The training room consists of numerous platforms, such as: PPGS, Wind-PV Hybrid Power Generation Systems, Wind Power Generation Equipments, Simulative Grid-Connected Power Generation System, Electronic Technology Application of New Energy, etc. This enables the students to obtain the project and professional skills training via the process of assembling, adjusting, maintaining, and inspecting, etc. various component parts of a photovoltaic and new energy power generation system, to further grasp the fundamental and related theoretical knowledge, to further reinforce their practical and operational skills, so as to improve their problem-analyzing and problem-solving abilities and to gradually become application-oriented specialists capable of integrating and installing a photovoltaic and new energy power generation system, and of providing technical services for it.

## 2. INSTALLATION AND ADJUSTMENT OF PPGS

The training platforms for the installation and adjustment of PPGSs are using a special X-type and four-quadrant installation structure, which can enable four groups of students to carry out the installation and adjustment at the same time, as shown in Figure 1. In total, there are six identical, fully equipped, training platforms in the training room, enabling 24 groups of students to conduct the project training simultaneously. The total time required to complete the training part of the course is approximately 52 class hours. Each group includes 2 to 3 students, who mainly work on the installation and adjustment of electrical components, control circuits, and solar panels. The training platform mainly consists of two large portions by the Photovoltaic Power Generation devices and the control platform.



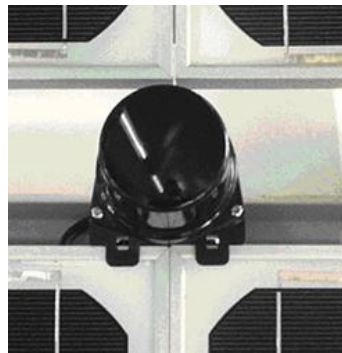
**Figure 1. The X-type and four-quadrant training platform**

### 2.1 The Automatic Solar Tracking Device of Solar Panel

The automatic solar tracking system of a solar panel is mainly composed by equipments such as: photovoltaic modules, a projection lamp, a light sensor, kinematic mechanisms for horizontal and pitching motions, an oscillating rod, a reduction gearbox for the oscillating rod, a support for the oscillating rod, a single phase AC motor, a DC motor for horizontal and pitching motions, a proximity switch, and a base support, etc., as shown in Figure 2.



**Figure 2. The automatic solar tracking device of the solar panel**



**Figure 3. Sunlight sensor**

With two photovoltaic cells in series and the other two in parallel, the matrix of photovoltaic modules consists of four photovoltaic modules. The light sensors are installed in the middle of the matrix. Two 300 W projection lamps are employed to imitate the sunlight, and are installed on the support of the oscillating rod. The bottom end of the oscillating rod is connected with the output end of the reduction gearbox, and the input end of the reduction gearbox is connected with the single phase AC motor. Through the reduction gearbox, the rotary electromotor drives the oscillating rod to oscillate circularly so as to simulate the path of Sun. At the bottom end of the oscillating rod, where it is connected with the base support, the proximity switch and inching switch are installed to protect and limit the position of oscillating rod. The horizontal and pitching movement mechanisms consist of the reduction gearboxes for horizontal and pitching motion, of the direct-current motors for horizontal and pitching motion, and of the proximity and inching switches.

As the direct-current motors for horizontal and pitching motion rotate, the reduction gearbox for the horizontal motion drives the matrix of photovoltaic modules to horizontally move towards the east or the west, while the reduction gearbox of pitching motion drive the matrix to pitch move towards the north or the south.

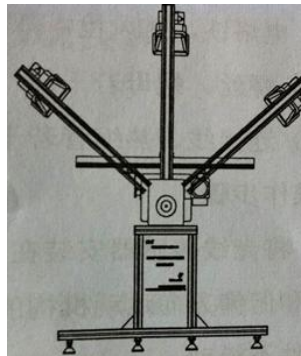
### 2.1.1 Sunlight Sensor

The sunlight sensor is installed in the middle of the photovoltaic cell matrix so as to receive the illumination of the project lamp at various positions. There is no output when the sunlight directly faced the light sensor, whereas the sensor would convert the intensity of illumination from the corresponding direction the binary signals and transmit them to the programmable logic controller (PLC) through the control box of

the sunlight sensor when the sunlight deviates in the east, west, south or north direction over 0.1 degree. Then the PLC would drive the corresponding horizontal or pitching electromotor to do the corresponding adjustment for the direction of the solar panel, so as to achieve the purpose of automatic solar tracking.



**Figure 4. The horizontal and pitching motion mechanisms**



**Figure 5. The schematic diagram of sun motion's simulation**

### 2.1.2 Motion Mechanisms

The horizontal and pitching motion mechanisms are as shown in Figure 4. There are two reduction gearboxes, namely, the reduction gearbox for horizontal motion and the reduction gearbox for pitching motion, which are driven through the driving chains by the direct-current motors for the horizontal and pitching motions respectively. The photovoltaic cell matrix is located above the motion mechanisms. When the horizontal and pitching motion mechanisms move, this drives the matrix of photovoltaic cells to move in the horizontal and pitching directions.

### 2.1.3 The Simulative Mechanism for the Sun Motion

The support of the oscillating rod is installed on the output shaft of the reduction gearbox for the oscillating rod, which is driven by the single-phase alternating current electromotor. Two 300 W projection lamps are installed on the upper end of the oscillating rod, forming the illuminant movement mechanism, as shown in Figure 5. When the alternating current electromotor rotates, the projection lamp moves circularly along with the support of the oscillating rod so as to simulate the sun motion via the continuous motion of the illuminant<sup>[2]</sup>.

## 2.2 Display and Control of Photovoltaic Power Generation Parameters

The PPGS mainly consists of: a display unit of photovoltaic output, a photovoltaic power generation control unit, the solar energy photoelectric controller of microcomputer, S7-200 PLC of Siemens, a relay set,

a storage battery, a circuit breaker, a 12V and 24 V power supply of two-way switch, and so on, as shown in Figure 6.



**Figure 6. The Platform of the PPGS**

### 2.2.1 Display Unit for Photovoltaic Output

The display unit for the photovoltaic output mainly consists of two sets of devices, each composed of a direct-current ammeter, a direct-current voltmeter, and connecting terminals. One set is used to display the voltage of the photovoltaic modules and the current which the modules charge to the storage battery. The other set is to display the voltage and the discharge current of the storage battery.

Besides the function of data display, all instruments also have a communicating function, which could enable the data transmission to the upper monitor for data collection and management.

An adjustable resistor with high power is connected to the direct current load to measure the VA characteristic curve for the battery components.

### 2.2.2 The Control Unit of PPGS

The control unit of the PPGS mainly consists of a selector switch, an emergency stop button, normal buttons, connecting terminals, etc. The panel of the control unit of PPGS is shown in Figure 7.



**Figure 7. The Control Unit of Photovoltaic Power Generation**

The buttons in Figure 7, namely the manual and automatic mode button of the selector switch, the start button, the stop button, the headlight button, the backlight button, the buttons for movements towards the east, the west, the south and the north, the buttons for moving the oscillating rod towards the east and the west, are applied to control the light, the oscillation of the oscillating rod, and the light tracking function of solar panel components under the manual and automatic conditions.

### 2.3 Inversion and Accumulation of Electric Energy

The storage battery consists of two lead-acid storage batteries, the charging process and charging protection of which are controlled by the solar energy controller of the microcomputer. When the output voltage of the photovoltaic power generation modules is higher than the rated voltage of the storage batteries, the controller charge the storage batteries.

The inversion part, including the off-grid inversion<sup>[3]</sup> and grid-connected inversion<sup>[3]</sup>, adopts the off-the-shelf inversion controller. Either inversion method could be employed. After the inversion, two AC meters displayed the AC voltage and the load current, the alternating current load motor and lamp start to work.

### 2.4 The Distributed Control and Data Management on the Upper Computer

The upper computer carries out the centralized management and control of the PPGS, collects the real-time data of each meter, stores these data, and displays them in the form of curves and report forms. Meanwhile, the upper computer communicates with PLC in real time, reads and displays the signals of various sensors, and achieves all the functions of the control box for the control unit. The software can be divided into four modules, according to their functions:

#### 2.4.1 Photovoltaic Power Generation System

This module collects, stores, and displays the output voltage and current of the photovoltaic components and of the storage batteries. Through communicating with PLC, it remotely controls the PLC, simulates the sun movement, and achieves the automatic solar tracking function.

#### 2.4.2 Inverter and Load System

This module collects, stores, and displays the alternating output voltage and current after inverter.

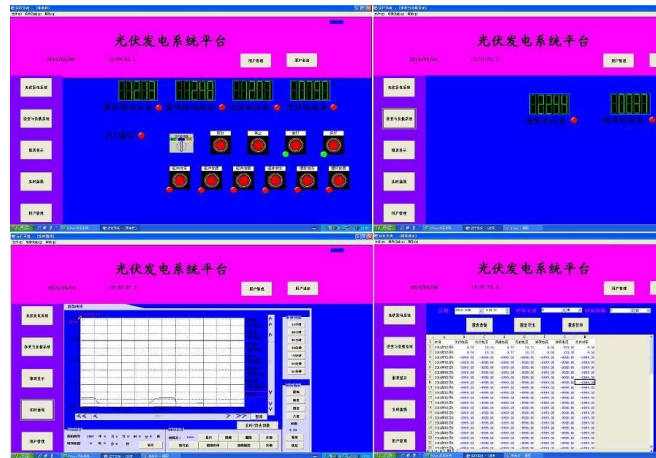


Figure 8. Main function interfaces of the upper monitor

#### 2.4.3 Real-Time Curve Display of Parameters

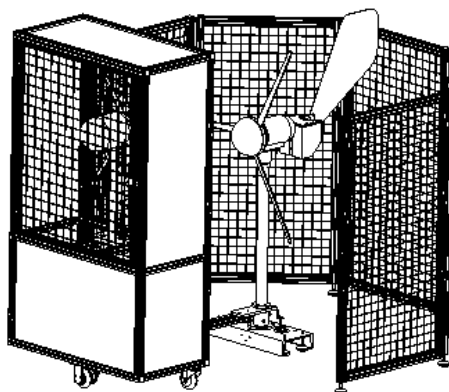
By means of graphic curves, this module intuitively displays the parameters of every meter, thereby reflecting the variation trends of various parameters.

#### 2.4.4 The Output Function of Report Forms

By means of report forms, this module displays, prints and exports the parameters during an arbitrary selected period.

### **3. WIND-PV HYBRID POWER GENERATION SYSTEM**

As an inexhaustible and clean energy, nowadays the wind energy is attracting more and more attention due to the increasing shortage of conventional energy resources. A wind-photovoltaic (Wind-PV) hybrid power generation system adopts the wind-driven generators and the solar batteries to convert the wind energy and the solar energy into electrical energy, with the two power generation systems integrated and being complementary in the same device. Therefore, the system can considerably improve the reliability of renewable energy resources, and it possesses great application value. In many places, the solar energy and the wind energy can be naturally supplemented by each other, as the solar energy available in summer is much greater than that available in winter, while the contrary is valid for the wind energy. Also, during the daytime, there is usually a high power load, while the power load is much lower at night. Therefore, the wind-PV hybrid power generation system can be used in real applications. It could dramatically improve the economy of a given system, and therefore it is believed to be a reasonable and economic solution in terms of energy structure.



**Figure 9. The Devices Simulating the Wind Power Generation**

Four wind-PV hybrid power generation systems are developed in the training room. The course could either be a supplement to the one on PPGSs, or be given independently. In terms of the photovoltaic power generation part, it is the same as for the plain PPGS; thus, in this paper, we emphasize the data collection and control of wind power generation system.

#### **3.1 Simulative Devices for Wind Power Generation**

The simulative wind-power-generation devices mainly consist of two parts: the device simulating the wind power, on one side, and the wind-driven generator and its protective device, on the other side. The wind power simulation device employs a frequency transformer to control an axial flow fan. The strength of wind power could be controlled by the speed of the axial flow fan, and the direction of wind could be adjusted through a motion mechanism of wind field. The wind speed could be gathered by a measuring instrument. The wind driven generator and its protective device could generate electricity; the steering tail rudder is used to adjust the axial direction of the wind driven generator. Due to the function of steering torque, the tail rudder of the electromotor is lined in the same direction as the wind. When the wind reaches a certain level, a yawing mechanism moves the tail rudder such as to reduce the frontal area of the vanes. This is done to protect the wind driven generator, and also to prevent the equipment damage from the high generating voltage or high speed. Taking security considerations into account, all devices are placed in a protection cover.

The motion mechanism for the wind field includes the axial flow fan, the support and protection cover, the transmission mechanism of gear chain, a single phase alternating current motor, a contact roller and an omni-directional wheel. When the single-phase alternating current motor starts to work, the transmission mechanism of the gear chain drives the contact roller to rotate. Meanwhile, the box of the motion mechanism in wind field revolves circularly around the tower of the wind driven generator. When the axial flow fan supplies the air-volume-variable wind, a wind field with alterable direction and speed is formed around the wind-driven generator<sup>[2]</sup>.

### 3.2 Wind Power Generation System

#### 3.2.1 Constitution of the Wind Power Generation System

The wind power generation system mainly consists of the control unit for the wind power source, the display unit for the wind power output, the touch screen, the control unit for the wind power generation, the charging/discharging control unit, the signal processing unit, S7-200PLC of Siemens, the relay set, etc.



Figure10. Wind-PV hybrid control system

#### 3.2.2 Control Method

The yawing function of the wind power generation control unit has two modes to control the wind direction, i.e., manual mode and automatic mode.

The air volume variation is achieved through the controlling of axial flow fan with frequency transformer. The output frequency of frequency transformer varies between 0-50Hz through manually operating the key-press on the operation panel. Thus, the speed of axial flow fan is changed between 0 and the rated speed, enabling the generation of a variable air volume.

#### 3.2.3 Charging/Discharging Control Unit and Signal Processing Unit

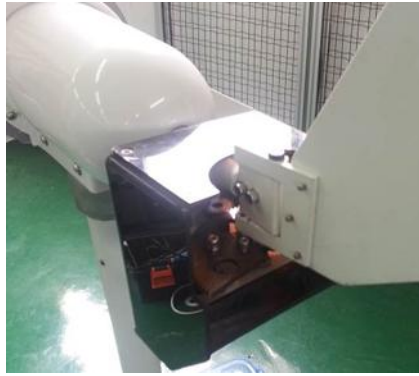
The charging process and the charging protection of storage batteries are controlled by the charging control unit, the signal processing unit and programs, while the discharging protection of storage batteries is controlled by the discharging control unit and the signal processing unit. When the discharge voltage of storage batteries is lower than the set value, the discharging control unit exports the signal to operate the relay so that its normally closed contact is opened and the discharge return circuit of storage batteries is switched off.

#### 3.2.4 Crosswind Yawing

These days, the large-scale wind driven generators all adopt the variable pitch wind wheels. This means that with increasing wind speed, the attack angle of airflow toward vanes may be adjusted according to the



variation of wind speed. As a consequence, while the wind speed exceeds the rated wind speed, the output power can be kept stably at the rated power. Especially, when the wind is very strong, the wind power generator is in a feathering state, which dramatically improves the force condition of both the paddles and the complete machine. When the wind speed exceeds the rated speed, the wind power generator can be protected from burning down because of overload, by altering the windward angle of wind flow and vanes.



**Figure11. The Yawing Device of Steering Tail Rudder**

In this training laboratory, a small-scale wind power generator with a wind wheel of fixed pitch is employed. Under the action of wind flow, the vanes of the wind wheel produce the rotary torque to drive the wind power generator. When the wind speed exceeds the rated wind speed, the yawing of crosswind<sup>[2]</sup> is adopted to control and adjust the windward angle of vanes so as to protect the wind power generator. Besides, the yawing of the crosswind is able to control the wind power generator at a constant output power.

A steering tail rudder is employed to achieve the passive yawing in the variable wind field, in order to produce the maximal electric energy. A velometer is employed to measure the wind speed in the wind field. When the wind speed exceeds the safe value, the yawing of crosswind controls the mechanism which moves the crosswind of the tail rudder to  $45^\circ$ , and the vanes of wind turbine generator are slowed down. When the air volume in the wind field is too much, the crosswind of the steering tail rudder is  $90^\circ$ , and the wind power generator is in the braking state.

### **3.3 The Distributed Control and Data Management on Upper Computer**

The upper computer carries out the centralized management and control of the wind-PV hybrid power generation system. It collects real-time data from each meter, stores these data, and displays them in the form of curves and report forms. Meanwhile, the upper computer communicates with PLC in real time, reads and displays the various sensor signals, and achieves all functions of the control box for the control unit. The software can be divided into five modules according to its functions.

#### **3.3.1 Photovoltaic Power Generation System**

This module collects, stores, and displays the output voltage and current of the photovoltaic components and of the storage batteries. Through communicating with the PLC, it remotely controls the PLC, simulates the sun movement, and achieves the automatic solar tracking function.

#### **3.3.2 Wind Power Generation System**

This module collects, stores, and displays the output voltage and current of the photovoltaic components and of the storage batteries. Through communicating with the PLC, it remotely controls the PLC and achieves the collection of wind force and the yaw control.

### 3.3.3 Inverter and Load System

This module collects, stores, and displays the output alternating voltage and current after the inversion.

### 3.3.4 The Real-Time Curve Display of Parameters

By means of the graphic curves, this module intuitively displays the parameters of every meter, thereby indicating the variation trend of various parameters.

### 3.3.5 The Generation of Report Forms

By means of report forms, this module displays, prints, and exports the parameters during an arbitrary selected period.

## **4. THE CURRICULUM DESIGN OF PRACTICAL TRAINING PROJECTS**

A clean and tidy working place is the foundation required in all institutions in order to improve the safety of the working environment. A favorable organization plan of the training place can not only ensure the security of the practical training environment, but also enhance the safety consciousness of the students. According to the actual circumstances of the training base and training rooms for installation and adjustment of the PPGS, this course was divided into 7 modules based on the management standard of Six S, i.e., Seiri, Seiton, Seiso, Seikeetsu, Shitsuke and Safety, where the contents and requirements of each module are as follows:

### **4.1 Module 1: Matters Needing Attention and 6S Management in Practical Training**

#### 4.1.1 Project Description

Get acquainted in advance with the situation and atmosphere of practical training; understand the relevant knowledge and skills related to safety operating and managing principles, the organization form and process of the practical training, and the basic functions of the devices. Be capable of operating and managing the training room in accordance with the 6S management standard, so as to develop good habits.

#### 4.1.2 Project Requirements

4.1.2.1 While connecting the modules and devices, strictly follow the requirements for the training steps.

4.1.2.2 Cut off the power supply while connecting or disconnecting the wires.

4.1.2.3 If you are the practical training teacher on site, when the students independently complete the circuit connection or reconnection, allow the power to be switched on only after your check of the situation, and attention should be drawn from the students. In case of a breakdown during the experiment, cut the power supply off immediately. Find the problems and handle them before the experiment is continued.

4.1.2.4 Be familiar with the requirements of 6S management.

### **4.2 Module 2: Familiarization with the Photovoltaic Power Generation Training Platform**

#### 4.2.1 Project Description

Relying on the photovoltaic power generation platform, familiarize yourself with: the PPGS, the inverter and load system, the modules of upper monitor system, as well as with the working principles, function and electrical wiring of each component equipment.

#### 4.2.2 Project Requirements

- (1) Understand the working process of photovoltaic power generation platform in accordance with the provided knowledge.
- (2) Be familiarized with the components and working principles of the systems.
- (3) Comprehend the electrical wiring between various equipment components.

### **4.3 Module 3: Wiring and Adjustment of Photovoltaic Power Generation System**

#### 4.3.1 Assignment 3-1: Wiring and adjustment of the photovoltaic battery matrix

##### 4.3.1.1 Project Requirements

- (1) Measure the open circuit voltage of photovoltaic cell components with a multimeter, under the condition of outdoor natural light, and understand the output voltage value of the photovoltaic cells.
- (2) Measure the open circuit voltage of the photovoltaic battery matrix with a multimeter under both conditions of outdoor natural light and indoor lamp light. Analyze the reasons for the difference in open circuit voltage between the conditions of indoor and outdoor light.

#### 4.3.2 Assignment 3-2: The influence of installation angle and intensity of illumination on the generating efficiency of photovoltaic modules

##### 4.3.2.1 Project Requirements

- (1) Measure the VA characteristic curve while varying the azimuthal angle, and draw the power curves.
- (2) Measure the VA characteristic curve while varying the intensity of illumination, and draw the power curves.

#### 4.3.3 Assignment 3-3: The practical training on adjustment of photovoltaic power generation devices

##### 4.3.3.1 Project Requirements

- (1) Complete the assembly of photovoltaic power generation devices.
- (2) Arrange the following: the power wires, signal wires and control wires of the horizontal and pitching motion mechanism, projection lamp, single phase alternating current motor, proximity switch, and microswitch.

#### 4.3.4 Assignment 3-4: Installation and adjustment of PPGS

##### 4.3.4.1 Project Requirements

First, learn the connecting and wiring methods of the system by using the electrical schematic diagram and the installed equipment. After getting acquainted with the principles of operation of the equipment and with the wiring connections, dismantle all the equipment parts; then carry out the layout, cabling and wiring of the module.

##### 4.3.4.2 Project Requirements

- (1) Dismantle the wire connections of the control unit for photovoltaic power source, the display unit of photovoltaic output, the control unit of photovoltaic power generation and PLC. The installed position of equipments could be properly adjusted. Reconnect the wires according to the electrical schematic diagram of the PPGS.
- (2) Select the reasonable diameters and colors of wiring which is labeled. All the wire ends should adopt the wire terminals.

### **4.4 Module 4: Installation and Adjustment of Simulative Solar Tracking System of Photovoltaic Modules**

#### 4.4.1 Assignment 4-1: Installation and adjustment of automatic light tracking system

##### 4.4.1.1 Project Description

(1) Learn the control process based on the understanding of the working principles of light sensors. Obtain the light tracking principles of solar panel through the electrical schematic diagram and teachers' explanation.

(2) Based on the understanding of electrical schematic diagram, conduct the installation and wiring of the experiment platform, including choosing the diameter and color of wires, and making the wiring labels.

#### 4.4.1.2 Project Requirements

(1) Understand the electrical schematic diagram, and comprehend the installation and wiring of devices and components.

(2) Dismantle the wire connections of PLC, and reconnect the wires according to the input and output schematic diagram of PLC.

4.4.2 Assignment 4-2: Designing the program dealing with tracking the simulative light source for the photovoltaic modules

#### 4.4.2.1 Project Description

(1) Check the input and output wiring of PLC according to the I/O configuration of the PLC.

(2) Based on the control requirements, draw up the manual and automatic program flowcharts of tracking the simulative light source for the photovoltaic modules, write out the programs, and accomplish the download and debugging.

### **4.5 Module 5: Testing and Training of the Photovoltaic System**

4.5.1 Assignment 5-1: The charge characteristic and the discharge protection for storage battery

#### 4.5.1.1 Project Description

(1) Understand the principles of charge and discharge protection for the storage battery, and the control principles of under-voltage relay and controller based on the platform of wind-PV hybrid equipment. Be capable of wiring.

(2) Check and test the actual charging waveform and the simulative charging waveform of the storage battery, and save the relevant screenshots.

(3) Simulate the discharge protection process of the storage battery by using the adjustable direct current power supply.

#### 4.5.1.2 Project Requirements

(1) Actually measure the charging waveform of pulse-width modulation for the storage battery.

(2) Through the simulative charging menu on the touch screen, test the charging pulse-width modulation waveform of the controller by using the oscilloscope under the condition of varying battery voltages and output voltages for the photovoltaic cells matrix.

### **4.6 Module 6: The installation and adjustment of dc-to-ac inverter and load**

4.6.1 Assignment 6-1: The installation and adjustment of the inverter circuit

#### 4.6.1.1 Project Description

Fix up the modules and connect the wires of equipment components according to the electrical schematic diagram of the inverter alternating load.

#### 4.6.1.2 Project Requirements

(1) Install the off-grid inverter, grid-connected inverter, air switch, AC motor, caution light and DC lamp.

(2) Wire according to the electrical schematic diagram of the inverter alternating load.

(3) Check the wiring, switch on the power to adjust after ensuring that the wiring is correct.

#### **4.7 Module 7: The installation and adjustment of the monitoring system**

##### 4.7.1 Assignment 7-1: Communication of the monitoring system

###### 4.7.1.1 Project Description

This assignment is based on the training platform for the wind-PV hybrid power generation system. The DC ammeter, DC voltmeter, AC ammeter and AC voltmeter of PPGS and inverter volt loading system employ the RS485 communication mode, and the communication interface is COM2. Meanwhile, the communication between PLC and upper computer also adopts RS485; the communication interface is COM1. According to the connection mode of communication interface, the communication wires were made to connect the devices.

###### 4.7.1.2 Project Requirements

- (1) Be familiarized with the communication modes between the upper computer, the PLC, ammeter, and voltmeter.
- (2) Be able to connect the communicating wires between the upper computer and each unit.
- (3) Connect the devices and debug the communication between the upper computer and each unit.

##### 4.7.2 Assignment 7-2: The application and development of configuration monitoring software Force Control

###### 4.7.2.1 Project Description

Familiarize oneself with the application of the configuration software Force Control through the practical training; fulfill the basic configuration for PPGS. Then, based on setting of the configuration of the I/O devices and of the database, accomplish the general appearance configuration, associate relevant variables, and complete the adjustment.

###### 4.7.2.2 Project Requirements

- (1) Familiarize oneself with the configuration software Force Control;
- (2) Fulfill the basic functions of configuration for the PPGS by using the configuration software;
- (3) Complete the communication, and debug the communication between the upper computer and each unit.

### **5. PROJECT PROMOTIONS AND MARKET APPLICATION**

This project involved the construction of two training rooms for the photovoltaic and new energy electronic technology, and for the installation and adjustment of a PPGS. The training room for the installation and adjustment of a PPGS consists of various training platforms, such as the training system for photovoltaic power generation, Wind-PV hybrid power generation system, Wind power generation equipment, Simulative grid-connected power generation system, Installation and adjustment of photovoltaic system, etc. Currently there is no off-the-shelf product on the market to meet the demands of practical training for the vocational college students in these areas. This training base was totally designed and developed by ourselves.

During the construction of this training base, innovations were made in both hardware and software. In terms of hardware, the principal innovation was the space saving. Due to the limited resources of the school, this training base was created while making full use of the pre-existing space. Also, the use of a four-quadrant mesh type structure extensively reduced the required space, and also brought about a very convenient and practical training experience. Besides, the training groups would not interfere with each other, having the students entirely fresh and ready for work.

In terms of software construction, the primary innovation was the in-depth development of the training projects. The pre-existing equipment was fully made use of so that the students of the major could

completely understand the core curriculum and the training contents. Secondly, the students were encouraged to boldly innovate. During the practical training activity, hands-on learning was used throughout, in order to motivate the students' creative thinking by means of independently designing, installing and adjusting the corresponding systems, all of which produced in the end better training results.

It is understood that by the fast speed of construction, the large scale, the multiple highlights, and the new technologies employed, the two training rooms are at the leading level compared with that of other vocational colleges. After the completion of the training rooms, many visitors at all levels came to view them, expressing the desire to emulate them, and giving them a very high appraisal, all which had a great value of popularization among the similar colleges.

## **6. CONCLUSIONS**

The two successful training rooms — namely the training room for the installation and adjustment of PPGSs and the training room for the photovoltaic and new energy electronic technology — provide the students majoring in the electric automation and photovoltaic technology and its application at the Changzhou College of Information Technology with commendable training platforms, which, while achieving the initial goals of construction, help by further improving their practical abilities and by cultivating their problem-analyzing and problem-solving abilities.

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