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Application and design of solar photovoltaic system

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Abstract. Solar modules, power electronic equipments which include the charge-discharge controller, the inverter, the test instrumentation and the computer monitoring, and the storage battery or the other energy storage and auxiliary generating plant make up of the photovoltaic system which is shown in the thesis. PV system design should follow to meet the load supply requirements, make system low cost, seriously consider the design of software and hardware, and make general software design prior to hardware design in the paper. To take the design of PV system for an example, the paper gives the analysis of the design of system software and system hardware, economic benefit, and basic ideas and steps of the installation and the connection of the system. It elaborates on the information acquisition, the software and hardware design of the system, the evaluation and optimization of the system. Finally, it shows the analysis and prospect of the application of photovoltaic technology in outer space, solar lamps, freeways and communications.

1. Introduction

Energy is material base of the economic development. To ensure the sustainable development of national economy, there must be the energy which can be continually provided for support. In the past 200 years, the energy system based on coal, oil, natural gas and other fossil fuel has greatly promoted the development of human society. However, material life and spiritual life is increasing, the awareness of serious consequences brought from the large-scale use of fossil fuels is increasing at the same time: depletion of resources, deteriorating environment, in addition to all of the above, it induce political and economic disputes of a number of nations and regions, and even conflict and war. After in-depth reflection of the development process of the past, human advance seriously the future path of sustainable development. Today in the 21st century, there is no a problem as important as a sustainable energy supply, especially for the benefit of solar energy development and has been highly concerned by all mankind. Around the world are faced with limited fossil fuel resources and higher environmental challenges, it is particularly important to adhere to energy conservation, improve energy efficiency, optimize energy structure, and rely on scientific and technological progress, development and utilization of new and renewable sources. In this paper, starting from the composition of the solar photovoltaic system, working principle and the photovoltaic power generation system design approach and design elements expatiate the steps and the idea of photovoltaic system design. Instructions for the applications of solar photovoltaic system in various aspects.

2. Solar photovoltaic system and operation principle

Solar photovoltaic system is power generation system of translating solar radiation into electrical energy directly using solar cell based on photovoltaic effect. Solar energy resources are dispersive and available everywhere, so solar energy photovoltaic power generation system is particularly suitable for use as an independent power supply. Solar photovoltaic system mainly includes three parts: solar components; power electronic equipment such as charge-discharge controller, inverter, test instrumentation and computer control; battery or other energy storage and auxiliary power generation equipment, as shown in Fig1. The working principle of photovoltaic power supply system is that the electricity produced from the solar component will charge for the battery controlled by the controller, directly to the load power supply in the context of meeting the load demand under the sunlight. The battery supply power for the DC load under the control of the controller if the sunlight is lack or at night. The converter is need to translate AC into DC for the photovoltaic system with AC load.

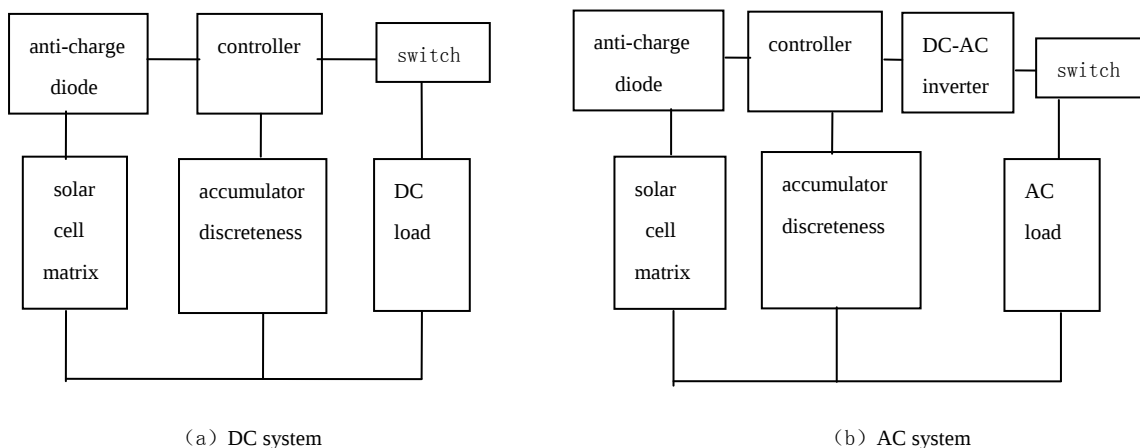


Fig.1 Solar photovoltaic system

2.1 Solar photovoltaic components

Consisting of solar components by series-parallel connection according to requirement converting solar radiation into electrical energy under the light, it is the core component.

2.2 Anti-recoil diode

Choose the appropriate rectifier diodes as anti-anti-charge in diode Solar photovoltaic system. Its role is to ensure the battery can discharge through the solar cell matrix when the solar cell matrix don't generate electricity or appear short-circuit fault in the rainy days and nights

2.3 Accumulator discreteness

Electric energy generated by solar power is stored, and the stored energy will release to meet the energy needs of the load when the light is insufficient, night, or the load demand is greater than the solar power.

2.4 Controller and inverter

Controller is the equipment of control and management solar photovoltaic system, its control has the two ways of logic control and computer control. The main complete function: First, detection of a variety of PV systems installations and the state and parameters of all modules for the system, provide the basis for judgement, control and protection; Second, optimal charging control for battery, the controller determine the optimal charging method based on the current status of battery in the state of solar energy resources, in order to achieve efficient, rapid charging, and fully consider the battery life with the charge method; Third, the management of battery discharge process; Forth, provide protection for electrical equipment connected to photovoltaic electricity system to prevent damage of the PV system or electrical equipment; Fifth, fault diagnosis positioning and operation instructions.

Inverter is the equipment turned DC into AC. Because the output of solar cell and battery is direct current, the inverter is indispensable when the load is AC load. The technical requirements of the inverter are: steady output voltage and frequency, adjustable in a certain range; a certain over loading capability; output voltage waveform with the smaller harmonic components.

2.5 Measuring equipment

According to the scale of solar photovoltaic systems, there are different detection and measurement of photovoltaic power generation system. Only simple measurements are carried for the small-scale solar photovoltaic systems, but more measurement parameters are called for large and medium-sized solar photovoltaic power plants, and industrial power systems, such as: solar power system communication, pipeline cathodic protection systems.

3. Design principles of solar photovoltaic system

3.1 Design principles of solar photovoltaic system

The overall principles of designing of solar photovoltaic system are: under the premise of electricity supplying meeting the load, the economy of the system is the best. Photovoltaic power generation system can be divided into software design and hardware design, usually software design is earlier than the general hardware. Software design includes the investigation of the load and estimating of load power consumption, calculation of radiation of solar cell surface matrix, the calculation of solar cell components and battery capacity, and the optimization match between them, the best calculation of square angle, the prediction of system performance and the analysis of cost-effective. Hardware design include the selection and design of the load, the choice of solar cells and batteries, the design of components and support of the array, the selection and design of inverter, as well as the selection and design of the control and measurement system.

3.2 Design methods and procedures of software and hardware of solar photovoltaic system

Photovoltaic system's designing is based on understanding and knowing many relevant information and carry out the necessary economic analysis. Mainly it has the following methods and steps:

The first is do the detailed inspection to the location of the photovoltaic system installation getting detailed information, including geographical location, weather data, on-site situation, load conditions, the user requirements and so on; the second is the calculation and design of software; the third is the design of system hardware. After the software is designed, it is necessary to consider the requirements

of the performance, and a relatively good economy; the fourth is the installation and connection of the system; the fifth is to do the monitor, evaluation, optimization to the operation of the system.

4. System design explain

4.1 For the detailed information

To accomplish the design task better ,you must acquire the accurate information before design of the software .Mainly do the follow works: The first is to do the detailed inspection to the location getting the geographic information including the longitude latitude deviation.The second is to analyze the weather data deeply, mainly including the all energy through radiation ,amount of direct dadiation ,amount of discrete dadiation, amount of anti-discretness radiation, maximum and minimum temperature ,the average and maximum speed of wind ,the hailstone ,snow and so on. Fig2 gives the curve of power consumption of every month in different seasons.

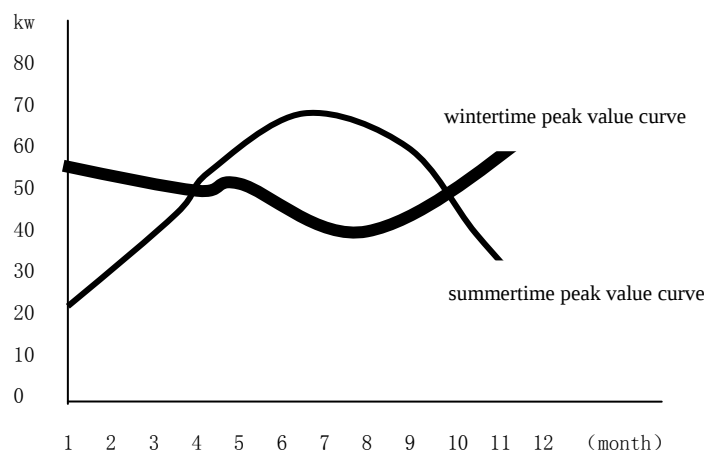


Fig.2 Curve of power consumption of every month in different seasons

4.2 Design of software

On the base of acquiring detailed information you can get down to the design of software for the solar photovoltaic system. The principles the you should always follow in the design of software are: under the premise of electricity supply meeting the load, the calculation of solar cell components and battery capacity should math the load power consumption furthest. This important principle decides the selection of solar cell component, the selection of battery capacity, the selection of best angle and so forth.

In the design, under the presime of considering the investment cost and the working condition of the load, you can consider using the mixed generating system to have a complementary system.

4.3 Design of hardware

Make software design prior to the hardware design .we should select on the base of detailed related information and the design of software before ,considering not only meeting requirement of function but also making it more economical .The details should be considered :the selection of diode, the

design of electric cable ,the design of prop stand ,the selection of controller and inverter ,considering installing following ,measuring and data collecting facilities with biggest power ,protection from thunder and lighting with ground contact ,square design field, the selection of auxiliary power source ,the design of transmitting and distributing electricity system and so on.

4. 4 Evaluation and optimization to the system

It is necessary to analyze the function of the solar and photovoltaic system for the solar and photovoltaic already built. the main purpose of function analysis is to know the working condition of the solar photovoltaic system ,seeing whether it can work normally. Find out the main factors that affect the system function through the analysis of various parameters, accumulating more experience data for the future solar and photovoltaic system.

5. Solar photovoltaic power and technology application

5.1 Solar light

The solar light is a solar-powered light, which is composed of solar components, batteries, charge-discharge controller, lighting circuits and poles, etc. Light, electricity, machinery, control technologies etc. That the light is gathering in integral whole and often integrates with the surrounding scenic environment. As long as sunny is enough it can install in situ, the light is a green environmentally friendly product and free from the effects of power lines, without ditching and embedding, non- consumption of conventional energy, and attracted a wide spread attention and application.

5.2 Solar car

With the arrival of the 21st century, the automotive industry advanced countries are researching and developing in energy saving and environment-friendly electric car. Solar-powered electric car developed rapidly in some developed countries as a result of advances in technology, especially the improvement of the cell and control technology. The primary users of solar-powered electric car are urban and rural middle-income residents, individual traders, and the tourism sector.

5.3 The application of PV in the communications

The most familiar application of solar photovoltaic power system is communications in the industrial field. Solar power used in unmanned microwave relay station, cable maintenance station, electricity / radio / communications / paging power systems, rural telephone carrier photovoltaic systems, small communication equipment, and soldier GPS-powered, etc.

5.4 The application of PV in the highway

Because of their unique characteristics of the highway, it is one of the solar photovoltaic place. Power supply system of highway plays a crucial role in the safety of the highway. In the urban areas of less electricity, if you use mains as power supply, the cost of pull-based power grid is very expensive. If using solar energy photovoltaic power generation on the highway to supply power to necessary electrical facilities, it is energy saving , environmental protection and economic security. Its applications is in the following areas: First, the service area on the highway which is away from the city power can build photovoltaic power station or photovoltaic-diesel hybrid systems, to supply area lighting, catering and other power needs to the service; The second is the emergency telephone system.

the highway pass through many remote areas, in order to deal with emergency incidents, an emergency call must be provided as a means of communication. Using the solar-powered long-distance transmission distribution equipment is not necessary, there is no transmission loss, safe and reliable when operate.

5.5 Applications in space

The first application field of photovoltaic technology is in space as a human satellite power, and later prevalence to the ground application. Solar cell can work in a wide range of sun intensity and temperature for a long period of time, with high reliability, high efficiency, long life and good anti-radiation properties, etc. making it obtain a wide range of application as a ideal space power. So far the vast majority of all types of aircraft launched into outer space by humanity are using solar cells as power supply.

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