Influence of Special Weather on Output of PV System

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Abstract. The output of PV system is affected by different environmental factors, therefore, it is important to study the output of PV system under different environmental conditions. Through collecting data on the spot, collecting the output of photovoltaic panels under special weather conditions, and comparing the collected data, the output characteristics of the photovoltaic panels under different weather conditions are obtained. The influence of weather factors such as temperature, humidity and irradiance on the output of photovoltaic panels was investigated.

Keywords. PV systems, output characteristics, environmental factor.

1. Introduction
When the traditional fuel energy is decreasing day by day [1], the environmental hazards caused by the emissions are becoming increasingly prominent. The greenhouse effect is becoming increasingly serious, the development of clean energy becomes imminent and about 2 billion people around the world have no access to normal energy supplies. At this time, the whole world is looking to renewable resources, hoping to change the human energy supply structure through renewable energy, so as to maintain sustainable development in the future. The solar energy resources will become the focus of attention, because the solar energy from the sun, is the inexhaustible natural green resources can be free to take, if it can be a good use of the solar light energy, so it can greatly reduce the consumption of other energy sources, greatly promote the development of the society.

2. Prospects of PV Power Generation

2.1. Future Trends in PV Power Generation
Renewable energy is a recyclable clean energy and is the ultimate energy option to meet the sustainable development needs of human society. PV power generation in the proportion of total energy consumption is small, but in some applications it is irreplaceable. And the photovoltaic panels can be recycled, the system material can be reused. The next ten years, China's solar photovoltaic industry will continue to develop a rapid stage.

2.2. Current Status of PV Power
China's solar photovoltaic power generation industry started in 1970s, and has entered a steady development stage in the middle of 90s. Solar cell production over Japan and Europe, especially in the
production of polysilicon materials has made significant progress, the main benefit from solar energy industry and long-term good of the entire PV industry the hitherto unknown investment boom.

It is of important theoretical and practical value to study the comprehensive output characteristics of photovoltaic power plants [2]. Because of the uneven distribution of solar energy resources, the uneven intensity of light and environment, and the randomness, fluctuation, periodicity and intermittence of photovoltaic output, many domestic scholars have carried on the related research [3-5]. In recent years, the construction of large and medium-sized photovoltaic power plants has increased, but the impact of environmental factors on the output characteristics of photovoltaic power plants has been relatively few in the actual operation. This paper takes photovoltaic panels as the research object, collects the actual data of Baoding area, collects the weather factors at that time, and collects the output data of photovoltaic panels in different weather, and using MATLAB and other tools for data analysis, different weather output characteristics are compared, to explore the special weather photovoltaic panels output characteristics.

Experiment Contents and Steps

2.3. Test Site Selection
In order to effectively collect experimental data, so as to get more reliable data, experimental sites should be selected and empty place, daylighting is good, and people less, to prevent the battery plate is damaged, and should be easy to import in Baoding after the experimenter, the playground of North China Electric Power University campus is right.

![Fig. 1 Experimental instruments and equipment](image)

2.4. Observations of the weather
Mainly to collect haze weather data; followed by sunny weather, this data acquisition to facilitate the comparison of the two, so as to better highlight the output characteristics of photovoltaic panels under haze weather. Rainy weather and snowy days, almost do not see the sun, the output is also very small, and so rainy days and snow days can’t collect data.
2.5. Acquisition time
In mid-December to mid-January, haze weather is more serious, collected during this period of photovoltaic power sheet data and daily weather conditions, and tabulation records. At the end of February and March, the weather was mostly sunny, and the data collected were mainly sunny weather data, and the weather information and watchmaking were collected at the same time.

3. Analysis of Output Characteristics of Photovoltaic Panels

3.1. PV Output in haze days
Select effective data in haze weather, using MATLAB for data analysis.

|        | 1  | 2  | 3  | 4  | 5  |
|--------|----|----|----|----|----|
| AQI    | 248| 356| 260| 215| 191|
| T/℃    | 0  | -4 | -4 | 0  | -2 |
| Irradiance /J*m⁻²| 189.8| 203.5| 67.2| 405.7| 246.7|
| Power/W| 10.42| 10.94| 10.95| 10.89| 10.39|
|        | 6  | 7  | 8  | 9  | 10 |
| AQI    | 218| 331| 235| 194| 107|
| T/℃    | -1 | 2  | 4  | 2  | -1 |
| Irradiance /J*m⁻²| 342.6| 329.4| 394.6| 368.4| 365.4|
| Power/W| 10.26| 10.07| 10.43| 10.86| 10.34|

After fitting the data, the fitting curve can be obtained as follows.

![Fig. 2 Power -AQI Curve](image)
It can be seen from Figure 2 that the influence of AQI on power has no obvious regularity, and is not stable on the whole, fluctuates greatly, and the curve exhibits multi peak characteristics. Therefore, the various pollutants of AQI have no easy to explore the law of photovoltaic output, while AQI mainly affects the power of photovoltaic panels by blocking light and weakening irradiance.

It can be seen from Figure 3 that the influence of temperature on power is somewhat delayed, although the curve is slightly fluctuation, the overall role is not very obvious, the impact is small.

It can be seen from Figure 4 that irradiance has the greatest influence on the power, and the two have obvious positive correlation. The curve obtained by linear regression shows obvious monotonicity, and the greater the irradiance is, the greater the power is.

3.2. PV output in clear weather

| Table 2. Experimental data of clear days |
|-----------------------------------------|
|  | 1    | 2    | 3    | 4    | 5    |
|---|-------|------|------|------|------|
| Humidity %RH  | 68    | 93   | 95   | 97   | 96   |
| T/°C          | 5     | 7    | 12   | 13   | 14   |
| Irradiance /J*m² | 382.4 | 357.4| 392.3| 373.1| 378.2|
| Power/W       | 10.33 | 11.05| 10.93| 10.99| 10.39|
| Humidity %RH  | 96    | 85   | 73   | 84   | 97   |
| T/°C          | 16    | 15   | 9    | 11   | 16   |
| Irradiance /J*m² | 341.8 | 331.6| 394.6| 368.4| 365.8|
| Power/W       | 10.26 | 10.07| 10.59| 10.86| 10.34|
The curve can be obtained by data fitting.

As shown in Figure 5 and Figure 6, the influence of temperature and humidity on power has certain volatility, and the influence of the two on power is hysteretic. There is a positive correlation before the temperature reaches a fixed value, and after a certain value, the temperature growth trend will increase the PV output. The influence of humidity on power is opposite to temperature.
The data of irradiance and power were fitted by linear regression method in Figure 7. The curve showed a monotonic upward trend, and irradiance had the most obvious influence on the power.

4. Conclusion
This paper mainly analyzes the output characteristics of photovoltaic panels under different weather conditions, and the output characteristics are greatly affected by various environmental factors. From the results of the fitting curve, the influence of irradiance on the output is the most obvious, showing a significant positive correlation. The effect of temperature on the output of the panels is weaker than the irradiance. In the sunny day, the fitting curve shows the nature of the multi-peak, haze weather, although the curve is slightly fluctuating, but the overall negative correlation, the higher the temperature, the output will be smaller. The effect of humidity on power has a negative correlation as a whole, but it also exhibits positive correlation in a certain region (90% - 95%), the power-humidity curve is gentle and the effect of humidity on the output is less than the temperature and irradiance. The effect of AQI on the output, the fitting curve is not obvious regularity, multi-peak and unstable, the main role of AQI is that the absorption of sunlight through the pollutants to reduce the amount of radiation to reduce the output of photovoltaic panels.

The results of this study can help predict the output characteristics of photovoltaic system, when the change of temperature and irradiance forecast factors of system output will be how to change, and positive effect on the power grid scheduling, and for the actual. The temperature range of the panel can be roughly determined by using the output characteristics of the PV system obtained from different typical days. It will help to prevent it from thermal damage, and real-time to determine whether the normal operation of photovoltaic systems.

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