PHOTOVOLTAIC SYSTEMS CONNECTED TO DISTRIBUTION GRID

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Abstract : Solar energy is the most important form of renewable energy. The production of electric energy based on photovoltaic modules is a method widely used in most European countries, even in those with a lower solar potential. The presentation focuses on photovoltaic generators connected to the distribution grid and the possibility of their application in Romania .

Keywords: photovoltaic systems, photovoltaic systems connected to grid, photovoltaic modules

1. INTRODUCTION

In the previous articles we presented the photovoltaic systems connected to the distribution grid and their structure:

- Photovoltaic panels
- Solar trackers
- Inverters
- Transformers
- Control and monitoring equipment

and their main advantages:

- the production and consumption is done in the same area;
- production of electric energy without any pollution;
- reliability, long lifetime;
- easy maintenance;
- technology without noise;
- low transport losses;
- doesn't produce any changes in the environment.

2. THE ARCHITECTURE OF A 5 MW PV-FARM

Below is presented the architecture of a 5 MW photovoltaic farm planned for north-west of Romania on 30,4 ha land. The operation mode of this system is based on the injection in the distribution grid of electricity, generated by the photovoltaic farm through 5 transformer/inverters that performs operations such as transformation from DC in AC, optimizes performance of the farm and secures protection of over voltage, short-circuits, etc.

2.1 Technical description of the PV-Farm

The concept of this farm is based on 600 trackers with two axis, equipped with 185 Watt mono-crystalline silicon modules, which are fixed in the ground with concrete foundations. Each full equipped tracker has a module area of 58m². The DC power from the trackers will be transferred to inverters which are connected to five 1 MW medium voltage transformers which are able to transfer the AC power into the distribution grid. Several 185 mm diameter cables are connecting the transformer with the power station.

Fig.1 Example of 2 axis tracker for the planned PV-farm

2.2 Planning phases of the PV-Farm

To ensure a successful project it is recommended to act according to a detailed project plan:

A. Basics – clarification scope of project, collect information like land, connection to transformer station.

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B. Preliminary Planning – etc. Budget cost analyses, ROI (Return On Investment) calculation, specific annual yield, grid feed-in. Selection of potential project partners
C. Blueprint Planning – prepare draft based on conclusion A & B
D. Approval Planning – building application, adjustment of preliminary planning, geo study
E. Construction planning – Creation of plans according to technical and economical requirements
F. Placing of orders – e.g. Modules, tracker, transformer/inverter, assembly, fence, security system
G. Manufacturing control – logistic-, assembly supervision, acceptance of work by official third party
H. Documentation – compilation of project records, warranties

3. TWO AXIS TRACKER SYSTEMS

The two axis tracker systems can be divided in two main categories:

- Astronomical tracker systems
- Tracker systems with sensors

3.1 Astronomical tracker systems

The so-called astronomical systems are working by programming the motion according to the annual movement of the sun, and through a program indicate the position of the sun in astronomical sky during each day of the year, and the solar panels are positioned always in the sun direction so they cannot react to cloud cover or other impairments, but are more efficient than fixed systems.

3.2 Tracker systems with sensors

In order to compensate the disadvantages of astronomical tracker systems, were conceived the tracker systems with sensors.

The tracker systems with sensors continuously position the mobile part of the tracker so that the solar modules are always oriented towards the brightest part of the sky, thus capturing the maximum possible amount of energy. This is realized with the help of two sensors sensitive to sunlight and which direct independently the vertical and horizontal orientation of solar panels. Sensors accuracy is less than 1 degree in the sunlight and less than 6 degrees in diffuse light (e.g. in the morning before sunrise or when it is cloudy). This type of solar trackers orients the solar panels to the most intense point of light in the sky, which is not always the direction of the sun. Often the reflected light or diffuse light when it is cloudy makes deviation from the direction of the sun visible to the eye. For example, during cloudy time the systems with sensors position the modules horizontally, capturing maximum energy. One of the very frequent "complaints" of customers of these systems was that in such of solar park each tracker had different orientation during cloudy sky, affecting the visual symmetry of the park (figure 2).

Fig.2 Sun Sensor -Degerenergie

Varying lighting conditions: In photovoltaic parks the lighting conditions vary for each single tracker because of different clouds (figure 3). The individual control aligns every sun sensor controlled tracker optimally to the brightest light source and guarantees therefore the biggest possible energy production.

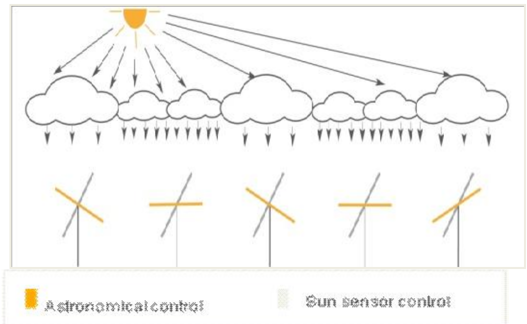


Fig.3 Sun sensor control

4. Wind protection

In order to protect the photovoltaic modules against strong winds, a wind speed monitoring system is used.

The programming of wind sensor system is made after the German standard DIN 1055-4. At wind speeds higher than 10 m/s all solar panels are oriented in horizontal position, which is the position with the lowest resistance to wind. If within 10 minutes there are no longer registered the same or higher speeds the solar panels are repositioned to the optimal orientation for energy production.

5. SNOW PROTECTION

In order to protect the photovoltaic modules against the snow deposits, a snow sensor is mounted parallel to the solar panels. This is a capacitive sensor capable of recognizing the amount of snow laying on the solar panels. When the maximum admitted quantity of snow is reached (35 kg/m^2 in our case) the tracker will orient the solar panels in vertical position. Snow will slide down on surface of solar panels, cleaning them also of other impurities. After that the solar panels will be repositioned to the optimal orientation for energy production (figure 4).

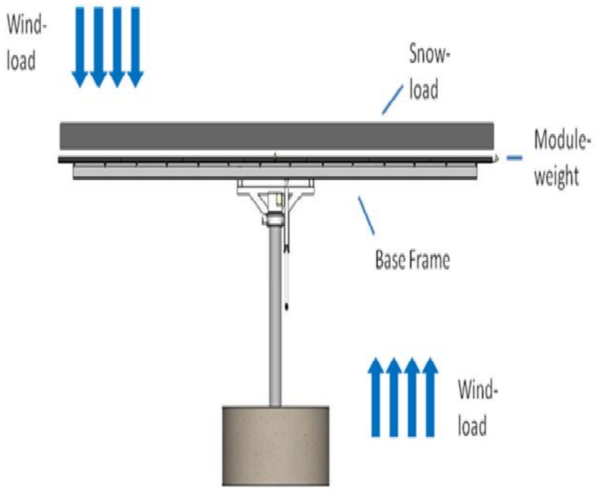
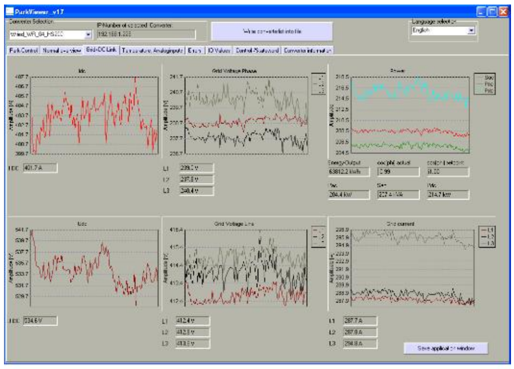


Fig.4 Schematic for snow-/wind sensor

6. MONITORING SOFTWARE

This ensures the monitoring and control of photovoltaic park parameters, both locally and remotely, thus ensuring an easy integration with the electricity distribution network.



7. CONCLUSIONS

In order to obtain a maximum energy production it is recommended the use of two axis tracker systems with light sensors which are ensuring an energy production up to 27% more than astronomically controlled systems, and up to 45% more yield than fixed systems.

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