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Prediction system based on domotic weather sensors for the energy production of solar power plants

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Abstract

The prediction of the electrical energy generated by a photovoltaic system is useful for estimating the profitability analysis of a project, without the need of expensive photovoltaic prototypes. Prediction systems are usually based on simulating the physical process of a photovoltaic module, under standard or average local weather conditions. These predictions introduce some errors caused by the use of a theoretical model or average climate data.

In our investigations, we noted that the energy generated by a photovoltaic system is proportional to the cumulative measurement of the sun illuminance that is provided by a low-cost domotic weather station. From this experimental observation, this paper proposes a hardware/software system for predicting the electrical energy generated by a photovoltaic system, such as those existing in buildings. The hardware consists of a domotic installation for monitoring both electric energy and climate parameters. The software consists of a calibration procedure, which provides a proportional factor between sun illuminance and the energy production per unit of surface area of the photovoltaic modules. Once the calibration procedure is completed, the photovoltaic energy production is predicted by factoring the sun illuminance provided by the weather station and the proportional factor provided by the calibration process. This method has been tested under real conditions and the accuracy reached up to 99.7% with an average value of 96.3%.

Keywords

Domotics, Energy prediction and forecasting, Sun energy, Power system operation, Smart buildings.

1. Introduction

Environmental concerns and the future shortage of fossil fuels keep interest in renewable energy sources. Nowadays, solar energy is a rapidly growing renewable energy source. Solar cells directly convert sunlight into electricity, with no noise and no air pollution, reducing the need for conventional fossil fuels. Photovoltaic grid connected systems arise as a result in the development of photovoltaic systems. Utility-scale photovoltaic power plants of several MW and building integrated photovoltaic systems in the range of kW are the two most usual ways for generating electricity from sun [2].

Domotic equipment consists of a set of computing elements that are distributed within the entire building. These elements are linked by one or several communication protocols, such as KNX, for data transmitting [3].

Many manufacturers of low voltage electrical equipment commercialize domotic devices. Among others, low-cost domotic weather sensors can be found. They also offer devices for connecting the domotic devices to a data network, in addition to metering devices for electric power and energy.

The development of domotic techniques for automation and metering of a building is an activity which grows in parallel with building integrated photovoltaic systems. Although home automation was initially focused on getting comfort and security [1], its techniques can also address to get energy efficiency.

A photovoltaic power plant and a domotic system can both coexist in a building, but they do not use to interact directly with each other [4]. A domotic system for recording the sun illuminance can be useful in estimating the power and energy production from a photovoltaic (PV) plant. That information can be transmitted through the building domotic system to the Operation and Control Centre of the bulk electric power system in that area.

An Electric Control Centre usually gets data from the actual state of loads, power transmission lines and conventional power plants. It also gets power production data from medium to large-size wind and solar power plants. The power system operator makes use of these data for performing tasks like State Estimation, Contingency Analysis, Unit Commitment and Economic Dispatch.