Perovskite Solar Cells

Modeling the Future of Renewable Energy

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Chapter 18

EXPLORING THE ROLE OF SOLAR ENERGY IN ADVANCING AGRICULTURAL PRACTICES

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Abstract

The sun is the ultimate and limitless source of energy. Solar power is a renewable energy source that comes from the sun and is released in the form of heat and light. Solar energy may be harnessed thanks to technological advancements. Solar panels, solar photovoltaic, solar heating and solar cooking may all be used to harness the sun's energy. Solar energy used with agriculture may aid in the development of sustainable farming. Keeping in mind that one day fossil fuels will end, a need arises to find alternative fuels. Renewable energy is considered an alternative to fossil fuels and nowadays it attracts much attention. Among renewable energy sources, solar is the most important because it is available in all parts of the world. Also, this energy source is used in various industries including agriculture and it can be used in cultivating crops in the farthest corners of the world. In present work, we have used Solar panels to power sensors and devices to monitor crops and fields, which can help farmers to improve their crop yields and reduce water waste. In proposed system we will monitor factors on a greenhouse such as temperature, humidity, unwanted occupancy, light intensity, pressure, rain fall detection, soil moisture, and water management. The data will be displayed and processed using a Blynk server with original hardware circuits on a permanent PCB. Using Node MCU and IoT technologies, we will present and evaluate the data. Even when there is no power source, system with solar panels offers power backup.

Keywords: Renewable energy, solar energy, sustainable farming, greenhouse, solar panel, Blyn server.

1.1 Introduction

Protected agriculture has become increasingly important worldwide amidst growing challenges such as global warming, the environmental crisis, and food insecurity [1]. Climate change has intensified extreme weather events, directly affecting agricultural production in

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many regions. Prolonged droughts, heat waves, and severe storms are becoming more frequent, creating an urgent need for more resilient agricultural systems [2,3]. In this context, protected agriculture, which includes greenhouses and crops under cover, provides a controlled environment that protects crops from inclement weather, allowing continuous food production even under adverse conditions [4,5]. Moreover, in a world where the environmental crisis demands sustainable solutions, protected agriculture offers a more efficient use of natural resources, which contributes to reducing the environmental impact associated with conventional agriculture [6]. Globally, this practice has become a key tool with which to address food security, protecting food production in a context of growing demand and limited resources [7,8]. The benefits of protected agriculture are numerous. Among the most outstanding are the increase in crop yields, the reduction in the use of agrochemicals, and the efficient use of water resources [9,10,11]. By creating a controlled or semi-controlled environment, growers can optimize plant growth, maximizing yields and improving product quality [12,13]. At the same time, by minimizing exposure to pests and adverse weather conditions, protected agriculture significantly reduces the need for pesticides and herbicides, promoting more sustainable and environmentally friendly farming practices while generating healthier food [14].

However, the success of protected agriculture and the achievement of the above-mentioned benefits relates largely to the ability to control the microclimate inside the greenhouses [15,16]. Factors such as temperature, relative humidity, solar radiation, and CO2 concentration can be regulated to provide an optimal environment for crop growth [8,17]. A controlled microclimate not only improves plant yields, but also allows for extended growing cycles, which is essential to meeting the world’s growing demand for food [18,19]. In addition, automation and the use of intelligent technologies such as sensors, climate control systems, and solutions based on the Internet of Things (IoT) allow these parameters to be adjusted in real time, ensuring greater precision in the management of internal greenhouse conditions. [20,21]. This, in turn, reduces dependence on external climatic conditions, improves the efficient use of water and energy resources, and reduces the use of water and energy [22].

Controlling the microclimate inside greenhouses, however, represents a technical and energy challenge. Traditionally, this control has been achieved through the use of heating and ventilation systems that rely on fossil fuels [23]. While these systems are effective, their environmental impact is considerable. The use of fossil fuels not only contributes to greenhouse gas emissions, but also generates high energy costs, posing both economic and environmental challenges [24,25]. In response to these limitations, the development of more sustainable solutions has gained prominence in recent years.

The use of renewable energies, such as solar and geothermal energy, has emerged as an effective alternative with which to supply heating and ventilation systems in greenhouses, considerably reducing dependence on fossil fuels [26]. The integration of photovoltaic systems into the roofs or structures of greenhouses makes it possible to generate enough electricity to cover operating energy needs, thus contributing to the energy self-sufficiency of these medium- and high-technology facilities [27]. At the same time, the implementation of passive ventilation systems [28,29] and the use of thermal storage make it possible to regulate temperature fluctuations without resorting to external energy sources in low- or medium-