Perovskite Solar Cells

Modeling the Future of Renewable Energy

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CRC Press
Taylor & Francis Group

Designed cover image: Shutterstock

First edition published 2026
by CRC Press
2385 NW Executive Center Drive, Suite 320, Boca Raton FL 33431

and by CRC Press
4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

CRC Press is an imprint of Taylor & Francis Group, LLC

ISBN: 9781032965031 (hbk)
ISBN: 9781032965055 (pbk)
ISBN: 9781003589747 (ebk)

DOI: 10.1201/9781003589747

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Chapter 20

REAL-TIME SOLAR PANEL PERFORMANCE MONITORING AND ENERGY FORECASTING

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Abstract

Solar Energy is established as an alternative source of energy known as renewable energy. In a developing country like India, the perspective of Solar Energy is important, as it supports a limitless source of energy. Monitoring and prediction of photo-voltaic energy generation help to reduce the energy loss and empower to utilize more energy. Solar energy prediction is challenging as it depends on the fluctuating solar radiations and climate conditions. The problem statement is to monitor electrical parameters of solar panels and predict energy generation for energy management procedure. In this chapter, the Internet of Things (IoT) is used as a powerful tool for developing a smart solar system-based energy meter. This meter is capable of transferring information efficiently regarding wireless energy consumption, and at the same time, it is capable of detecting the usage of electricity of solar panels using IoT. A sophisticated digital gadget called a smart energy meter was created to take the place of the conventional electricity meter. By enabling us to manage and lower our energy use, installing a smart meter will help us do away with projected costs. It has the ability to acquire data remotely and submit meter readings to energy providers. The aim of the present work is the measurement of electricity produced by solar panel. Proposed system monitors solar panels and predict the future energy generation for energy management in IoT base environments. The circuit in the current work is interfaced with the ESP32 Wi-Fi module to examine all the requirements for an electrical energy meter using the SCT-013 current sensor and ZMPT101B voltage sensor. The system can send the solar panel data to the Blynk server from all over the world. On the Blynk application dashboard, the voltage, current, power, and overall unit utilized are displayed in kWh.

Keywords: Energy systems, Energy audit, Energy meter, ESP32, SCT-013, ZMPT101B, Blynk server.

 DOI:I0.I20I/978I003589747-20

1.1 Introduction

Fossil fuels, the traditional primary energy source, are being depleted at an alarming rate due to increasing demand, raising concerns about an imminent energy crisis. Burning fossil fuels has caused the atmospheric concentration of carbon dioxide to rise, which has resulted in extreme weather patterns [1-3]. As a result of global industrialization, the climate has become abnormal and humanity is struggling to survive. To meet the given challenges of energy crises, alternative energy sources are developed with little to no emissions of greenhouse gases like carbon dioxide (CO2) because they do not come from fossil fuels. As a result, the greenhouse effect that causes climate change is not exacerbated by the energy produced from non-conventional sources. Solar energy, geothermal energy, hydroelectric energy, biomass energy, wind energy, and nuclear energy are some examples of alternative energy sources [4]. The demand for energy is rising in many countries throughout the world as populations and income levels rise. Between 2017 and 2018, the world's energy demand climbed by 2.3%, and between 2018 and 2019, it increased by 3.1%. After decreasing by 4.5% in 2020, the world's energy consumption returned with a 5% growth in 2021 [5-6].

According to the International Energy Agency (IEA), Renewable energy will be the fastest growing source of electricity, in which wind and solar PV are technologically mature and economically affordable. Adopting Renewable Energy technologies is one of the advance ways of reducing the environmental impact. The latest edition of the IEA's Medium-Term Renewable Market Report specifies the renewable energy growth about 13% more between 2015 and 2021 than it was in last year's. The share of renewable energy in overall electricity generation will rise from over 23% in 2015 to almost 28% in 2021. Solar energy is universally available all over the world and can contribute to minimize the dependence of energy imports. In 90 minutes, enough sunlight strikes the earth to provide the entire planet's energy needs for one year. Solar PV leads to no greenhouse gas (GHG) emissions and other pollutants during operation [7]. Solar has many benefits like system-friendly deployment, improved operating strategies, advanced renewable energy forecasting and enhanced scheduling of power plants and also investment in additional flexible resources, comprising demand-side resources, electricity storage, grid infrastructure and flexible generation. The traditional method focuses on the levelized cost of electricity (LCOE) which is a measure of cost for a particular generating technology at the level of a power plant that is no longer sufficient. About a million solar panels were installed every day around the world last year. Solar PV leads providing almost 40% of global renewable electricity capacity growth over the medium-term. Finally, in analysing the evolution of electricity and energy- consuming sectors, it explores the prime role solar energy could play in the long-term future of our energy system. Applications of the monitoring system [8] are the Rooftop Solar, Ground mounted Solar, Solar cities, Smart villages, Micro grids and Solar Street lights. Consumer Products like solar water heating systems, Solar home lighting systems, solar lanterns, solar pumps, solar mobile chargers, solar cookers, LED solar torch, solar RO plant, solar fan, solar Inverters, etc. can be monitored through smart energy meter. Commercial Products like Solar traffic signals, solar road studs/blinkers can also be monitored through the proposed smart energy meter. In India, frequent power cut is very common. Due to this issue, it is important to use renewable energy and monitoring it. By monitoring the energy forecast, households