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ENHANCE EFFICIENCY OF SOLAR ENERGY CONVERSION SYSTEM USING ANFIS WITH ISOLATED MODE

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Abstract- This paper shows performance investigation on enhance efficiency of standalone solar energy conversion system using ANFIS based MPPT controller. Now a days many researches are going in the field of renewable energy technologies to bridge the gap between supply and demand. Due to the Intermittent nature of renewable sources, operating standalone operation of them is highly unreliable causes interruption in power supply to the load. A solar photovoltaic system with MPPT based on Adaptive-Network-Based Fuzzy Inference System (ANFIS) is used for stable operation and to meet the supply with the load demand. The application of ANFIS based MPPT technique requires detailed study and analysis of the Solar Photovoltaic (SPV) system. Adaptive-Network-Based Fuzzy Inference System based MPPT technique is used along with Solar PV system as they can provide fast and accurate response to various environmental conditions. The Levenberg-Marquardt algorithm is used to train the neural network for MPPT in the photovoltaic system. This developed control strategy is able to control the devices and various power interface circuitry used therein. The main aim of this paper is to ensure a maximum power output coordinating appropriate control strategy with sources & compare the performance analysis of the ANFIS based MPPT with conventional incremental conductance based MPPT for the SPV system. The simulation studies have been carried out to find out the SPV system performance with different input conditions such as typical solar radiation and temperature. The Simulation test results show variable power generation and verifies that the performance of the integrated system with this control strategy is effective for the real-time installation. The simulation results shows that the performance of this developed control strategy for receiving maximum power output from the standalone SPV system is farfetched.
Simulation test results show variable power generation and verify the performance of the integrated system with control strategy is overall effective for real-time installation. The developed system is essential in an isolated region where an existing grid is unable to supply secure power generation and system is beneficial with smartly feed ultimate power generation sources.
Keywords: Adaptive-Network-Based Fuzzy Inference System (ANFIS), Maximum Power Point Tracking (MPPT), Photo voltaic array (PV array).

1. INTRODUCTION

Increase in energy requirements leads to rise in production of these fossil fuels. For sustainable energy growth in any nation or state, it must fulfill all requirement of the electricity supply [1,2]. The world is moving towards extensive utilization of renewable energy in recent days as a solution for the energy crisis. Growing electricity demand, increasing fuel prices, and greenhouse gas emissions have led us to turn to renewable energy resources, such as wind and solar power, for their higher potential to solve these issues. However, renewable energy faces two major dispatch ability issues: technical and financial [6-8]. Renewable energy sources are the solution of these issues. Renewable energy sources cause less pollution as compared to fossil fuels. Solar energy, Wind energy, Geo-thermal energy, tidal energy etc [8.9]. are the type of renewable energy sources. Renewable energy sources play an important part in electric power generation; solar energy is a good choice of an electric power generation.

Renewable energy is an energy sources that can replace rapidly conventional sources by a natural process such as solar, wind, hydro, geothermal etc. and provides sustainable energy. At the grassroots level, fig. 1.1 shows working of solar energy conversion system[10].

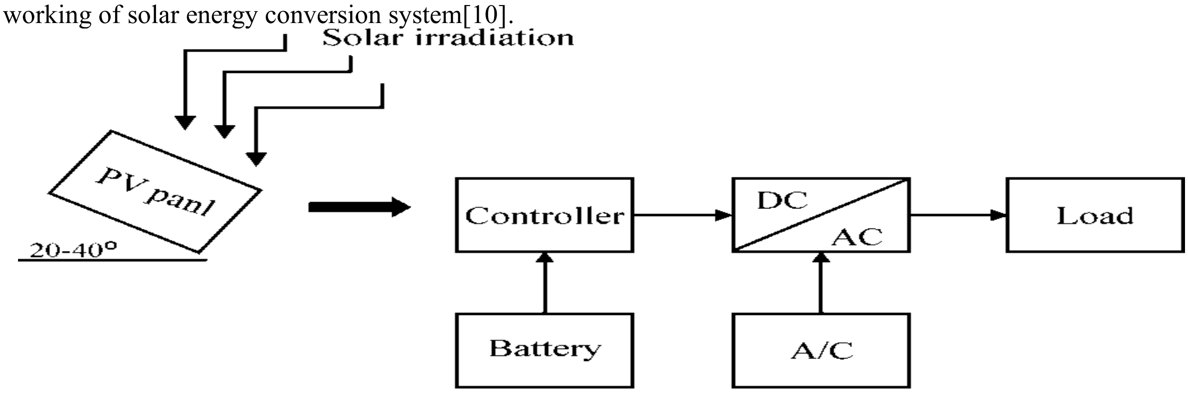

Fig. 1.1 Solar Power Generation

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2. PROPOSED SECS USING ANFIS BASED MPPT CONTROLLER

This system shows implementation of various components of the proposed system details about modelling of PV array, study of Power electronics interfacing devices such as DC-DC converter and ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT Controller.
A simple block diagram of DC-DC converter for SECS using ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT Controller is shown in Fig. 2.1. Proposed system consists of PV array, power electronics interfacing devices such as DC-DC Boost converter, load arrangement and ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT Controller. In order to improve the performance of maximum power point tracking of solar PV system, an effective ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT Controller is developed and compared with the conventional ANN based MPPT controller.

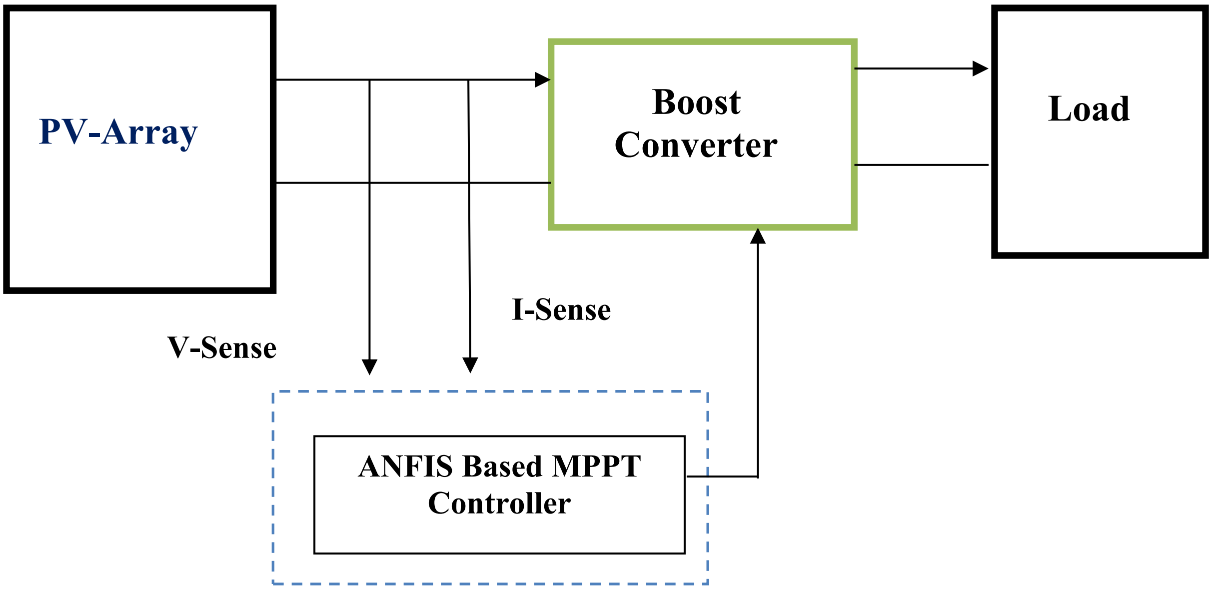

Fig. 2.1 Block Diagram of DC-DC converter for SECS using ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT Controller

In the proposed system interconnection is done through the DC-DC converter, which adjusts the DC power of Solar PV array. This system consists of solar array directly tied to the DC-DC boost converter, this DC-DC converter connected to load R. ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT controller uses the PV voltage and current as an input and output the duty ration for the PWM controller which acting at 4kHz switching frequency.

3. MATHEMATICAL MODELING OF SECS

3.1 PV Array Modelling

Parallel structure of PV arrays has higher efficiency than series structure due to their performance. The output current can achieve much higher amounts with parallel PV arrays, on the other hand, the voltage produced by a parallel structure is low, and so the structure cannot be used alone. Making solar cells series and parallel, we can achieve reasonably current and voltage.

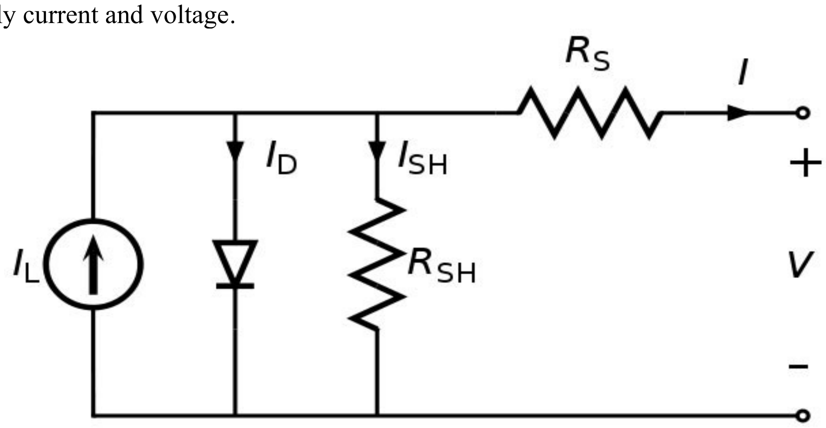

Fig. 3.1 The equivalent circuit of a solar cell

According to this model, current-voltage characteristic of a solar module is obtained using the following relationship:

$$I = I_{ph} - I_{RP} - I_D \quad (3.1)$$

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$$I_{RP} = \frac{V_m + R_S I_m}{R_P} \tag{3.2}$$

$$I_D = I_s \left(\exp\left(\frac{V_m + R_S I_m}{m \eta V_T} \right) - 1 \right) \tag{3.3}$$

3.2 Control of the boost converter with MPPT Controller

From the characteristic I-V and P-V curves of photovoltaic modules, it is shown that there was a unique point for the maximum power (PMPP). This point is defined as the maximum power point (MPP) with the optimal voltage V_{mpp} and the optimal current I_{mpp}. At this point, the entire PV system should operate with the maximum efficiency and produce its maximum output power.

Fig. 3.2 described the flow chart of IC method. At the input, there are the photovoltaic voltage and photovoltaic current. The power is then calculated from those two parameters. The sign of the power determines the duty cycle output of the MPP controller. In simulation, the duty ratio of the boost converter is the control variable. Perturbing the duty ratio of the converter perturbs the PV array current Ipv and consequently perturbs the PV array voltage. The initial value of the duty cycle and PV power are given. The voltage and current of the PV array are measured first and then the power P is calculated. The power is then compared with the previous value. If the difference is positive, the duty cycle is incremented. The switch used is ideal and the boost output voltage is supposed to be constant. The range of the duty cycle is limited between zero and one to ensure that the boost will step up the input voltage within limit.

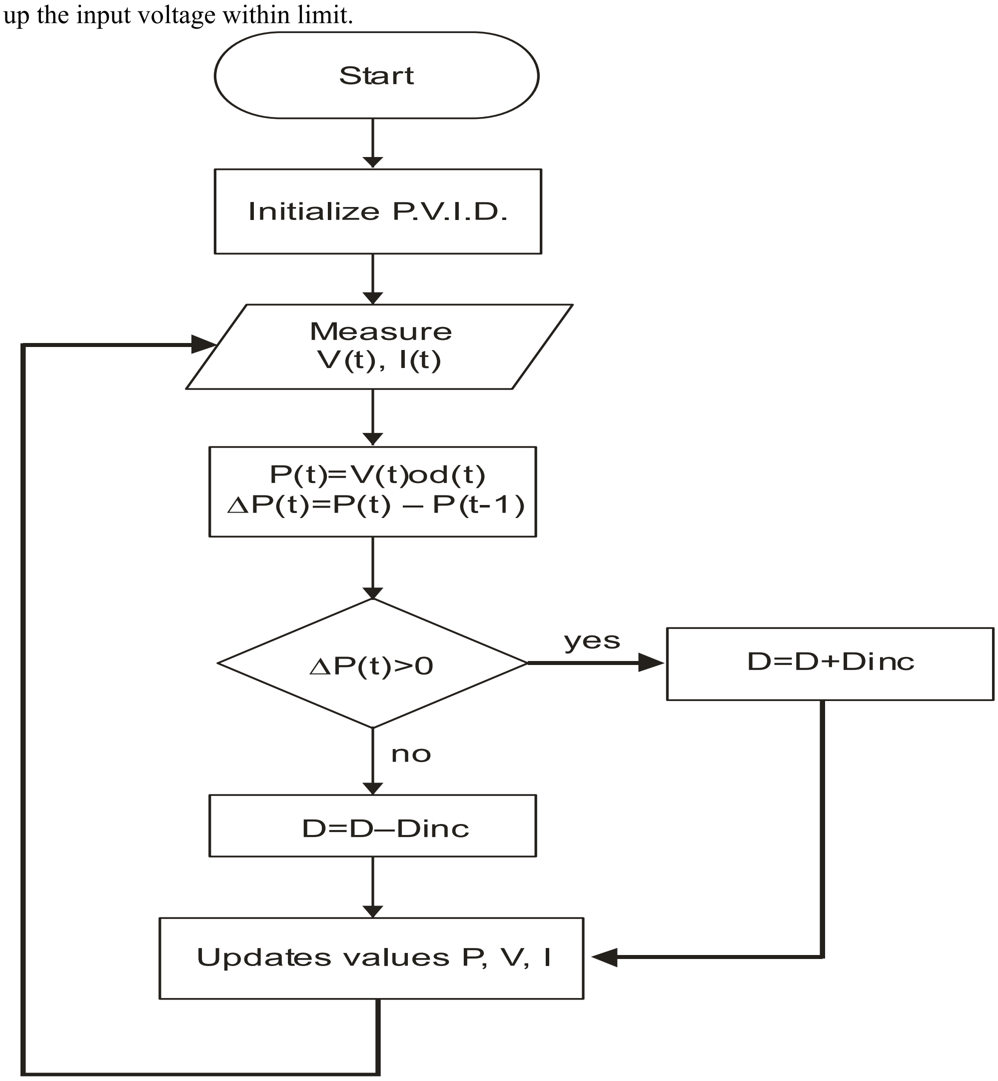

Fig. 3.2 Flow chart for Incremental Conductance

4. RESULTS AND DISCUSSION

In this paper shows the proposed system performance of DC-DC boost converter for Solar Energy Conversion System with ANFIS (Adaptive-Network-Based Fuzzy Inference System) MPPT Controller at Constant Irradiance at 1000 W/m^2 with Resistive Load of 2 kW. Figure 5 displays ANFIS (Adaptive-Network-Based Fuzzy Inference System) model structure. There are two inputs are taken and one output is derived. The two inputs are PV voltage and PV current and one out is the duty ration for the boost converter.

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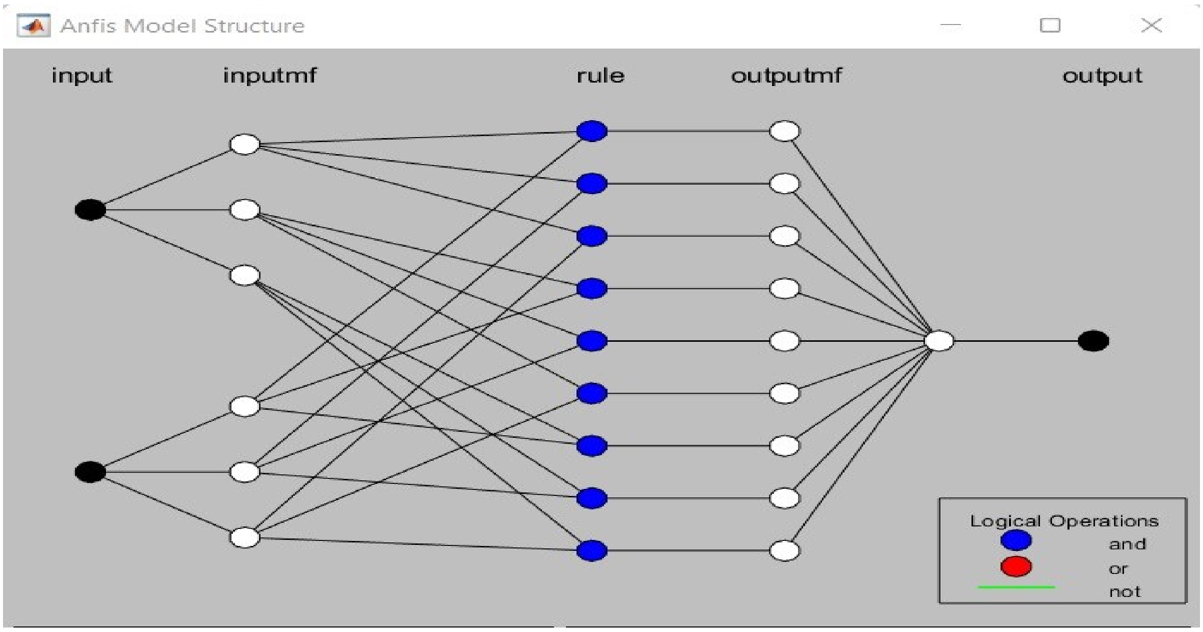
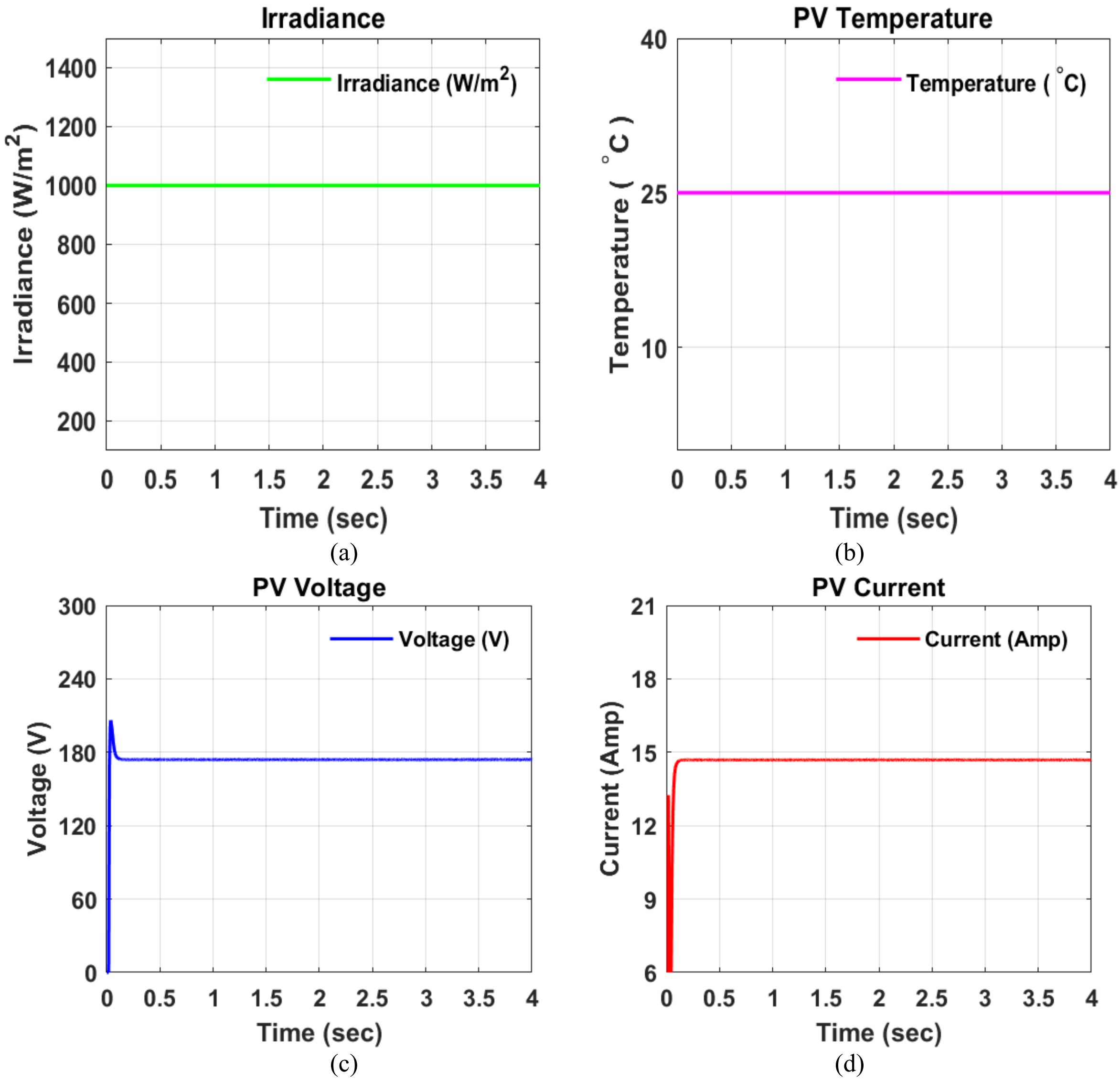


Fig. 4.1 ANFIS (Adaptive-Network-Based Fuzzy Inference System) Model Structure

Fig. 4.2 display simulation results of PV array with the ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT Controller. Waveform of Irradiance, Temperature, PV output voltage, PV output current and PV output power & irradiance is shown in this figure. Temperature is kept constant at 25° C and Irradiance is at 1000 W/m^2 with Resistive Load.



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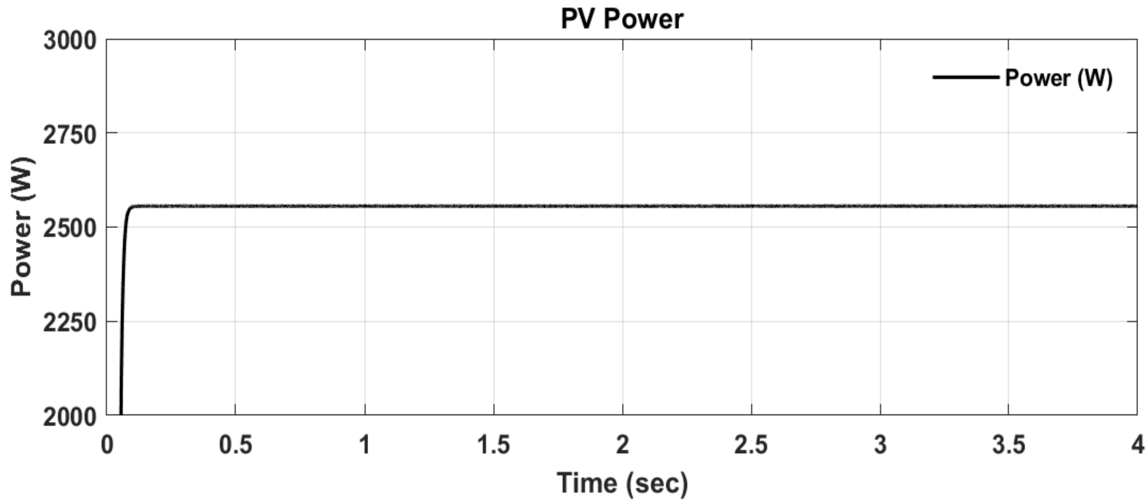
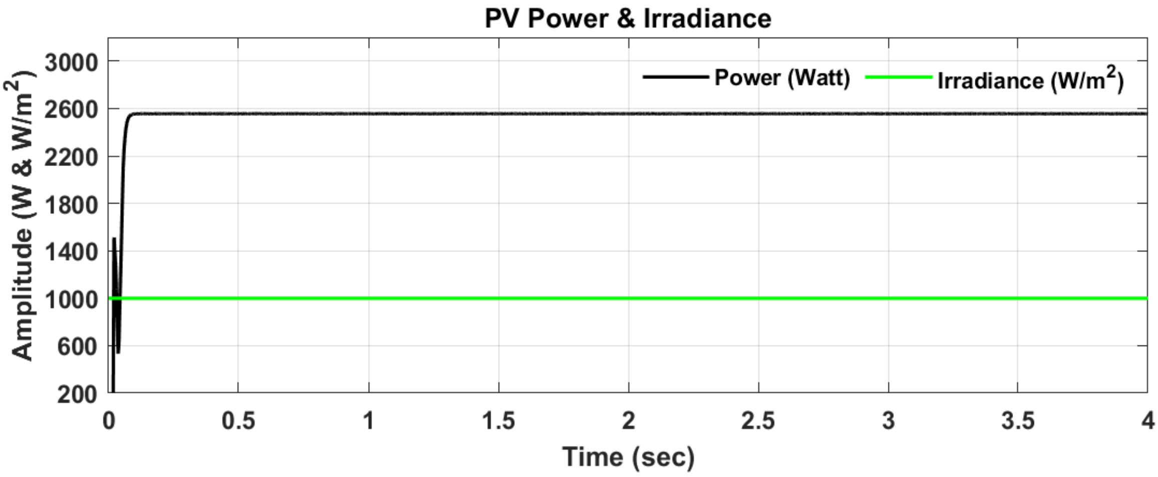


(e)



(f)

Fig. 4.2 PV Array Results at constant Irradiance at 1000 W/m^2 with Resistive load: (a) Irradiance, (b) Temperature, (c) PV-V, (d) PV-I, (e) PV Output Power and (f) PV Output Power with Irradiance

CONCLUSION

The present paper is carried out for PV array and DC-DC Boost converter for SECS. Duty ratio of DC-DC Boost converter generated by the proposed ANFIS (Adaptive-Network-Based Fuzzy Inference System) based MPPT Controller are smooth and shows better dynamic performance. It shows in results that Output voltage of the PV system is nearly 175 V during the total simulation time, PV output current is 14.5 A and PV output power reach at 2550W. The Solar energy conversion system model was developed in MATLAB/Simulink software and control strategy for MPPT of the developed system is also presented.

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