PERFORMANCE MONITORING AND FORECASTING OF GRID CONNECTED ROOF TOP SOLAR PLANT

Dr. S. Prakash, Professor/E.E.E Department, BIHER-BIST, Chennai, E-Mail: prakash.eee@bharathuniv.ac.in

Dr.A.suresh, Professor, Amet University, Chennai. E-Mail : drsuresha@ametuniv.ac.in

G.Varunkumar, P.G.Scholar , BIHER - BIST, Chennai, E-Mail: varun2406@gmail.com

ABSTRACT

Tamil Nadu is with rich solar energy and if exploited efficiently, the state has the potential of producing million-kilowatts of electricity. Sunlight is converted to electricity directly. In recent years solar PV systems became viable and attractive. Available roof-top area on the buildings can also be used for setting up solar PV power plants, and thus dispensing with the requirement of free land area. The electricity generated from SPV systems can also be fed to the distribution or transmission grid after conditioning to suit grid Integration. The grid integration of PV power has become a topic of research interest due to climate change and global warming in recent years.The accurate forecasting of PV power generation is essential because of the need to meet the increasing energy demand, mitigate climate change, and stabilize electric grid systems. So we present a review in this paper on today's policy and status of grid connected roof top PV system performance monitoring and forecasting inTamil Nadu.

Keywords: Roof Top Solar Plant, Performance Monitoring, Forecasting, Solar Policy 2019.

1. INTRODUCTION

175 GW target of Renewable Energy by MNRE Central Government. To reduce the carbon foot prints and limiting the global warming to 1.5 C based on Paris Agreement. Tamil Nadu Solar Policy 2019 - Use regulator mechanisms to ensure that Tamil Nadu will achieve or exceed the solar energy portfolio obligations as may be determined by the TNERC (Tamil Nadu Regulatory Commission) from time to time. Consumer Category Systems – where the objective is self-consumption of solar energy and export of surplus energy to the grid. For these systems the grid connection is through a consumer service connection of a distribution licensee. Tamil Nadu Vision 2023 - will have an installed solar energy generation capacity of 9000 MW by 2023. Of this target, 40% be earmarked for consumer category solar energy systems.According to the same agency, electricity demand is projected to grow at an average annual rate of 2% per year in the period of 2019 to 2030.

2. ROOF TOP SOLAR PROMISING FUTURE FOR TAMIL NADU

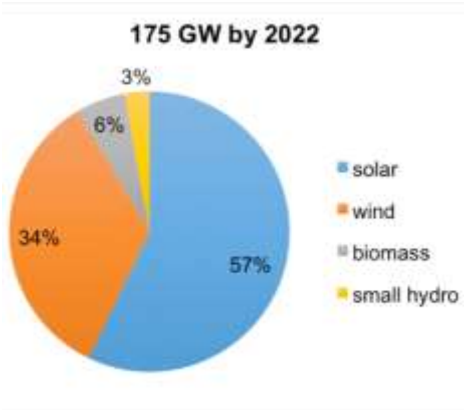


Fig.1.Power Generation Scenario

Fig.2.Power Generation by Source (%)

3. GRID CONNECTIVITY AND ENERGY EVACUATION

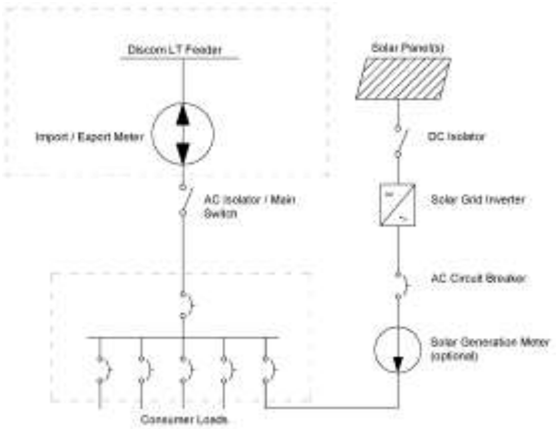


Fig.3.Grid- Interactive Rooftop Solar PV Single Line Diagram

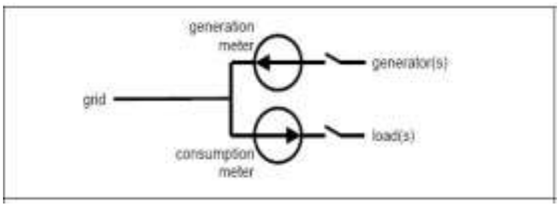


Fig.4.Feed-in tariff mechanism

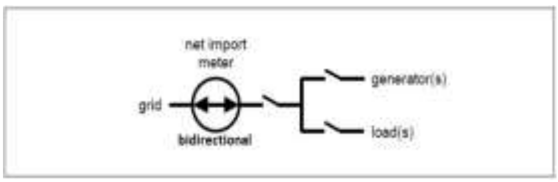


Fig.5Net-metering

4. PROPOSED ANALYSIS OF GRID CONNECTED SOLAR PLANT

Due to the fact that the actual characteristic of PV power generation is critical to determining the suitability of the PV power performance monitoring and forecasting method, in advance, a deep and specialized analysis of nonlinear dynamics of PV plant and its external determinants such as the changing of solar irradiance and ambient temperature is carried out in the paper. On this basis, a PV power forecasting method using an adaptive back propagation (BP) neural network with scrolling time window technology is proposed. As a result, the paper is divided into two parts first to analysis of characteristics of PV output power under internal and external excitation conditions is performed and an introduction to the nonlinear and time-varying characteristics of PV output power is given. Second introduction to the BP neural network algorithm and scrolling time window technology is provided. Detailed principles of the adaptive BP neural network with scrolling time window are also introduced. In Chapter 4, the determination of the time window size of the scrolling forecasting model based on a rational experimental scheme is given, as well a validation analysis of the performance effectiveness of the proposed model and the annual prediction model.

5. CIRCUIT AND SIMULATION DIAGRAM

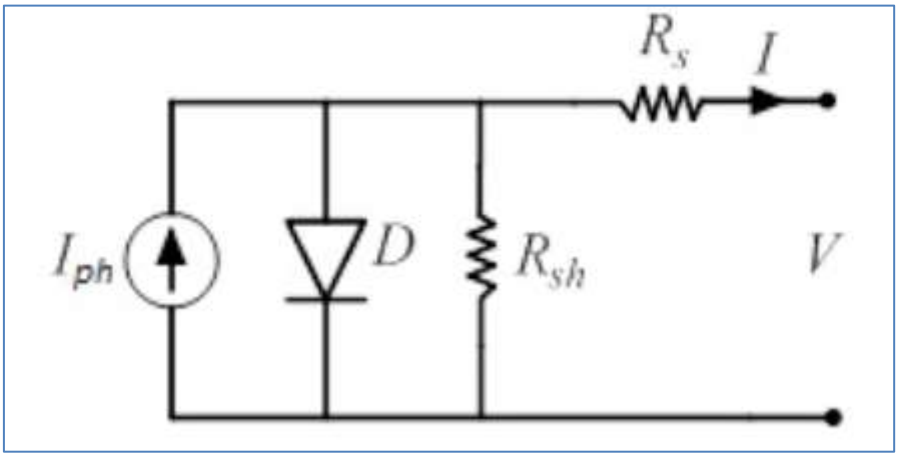


Fig.6. PV cell equivalent circuit

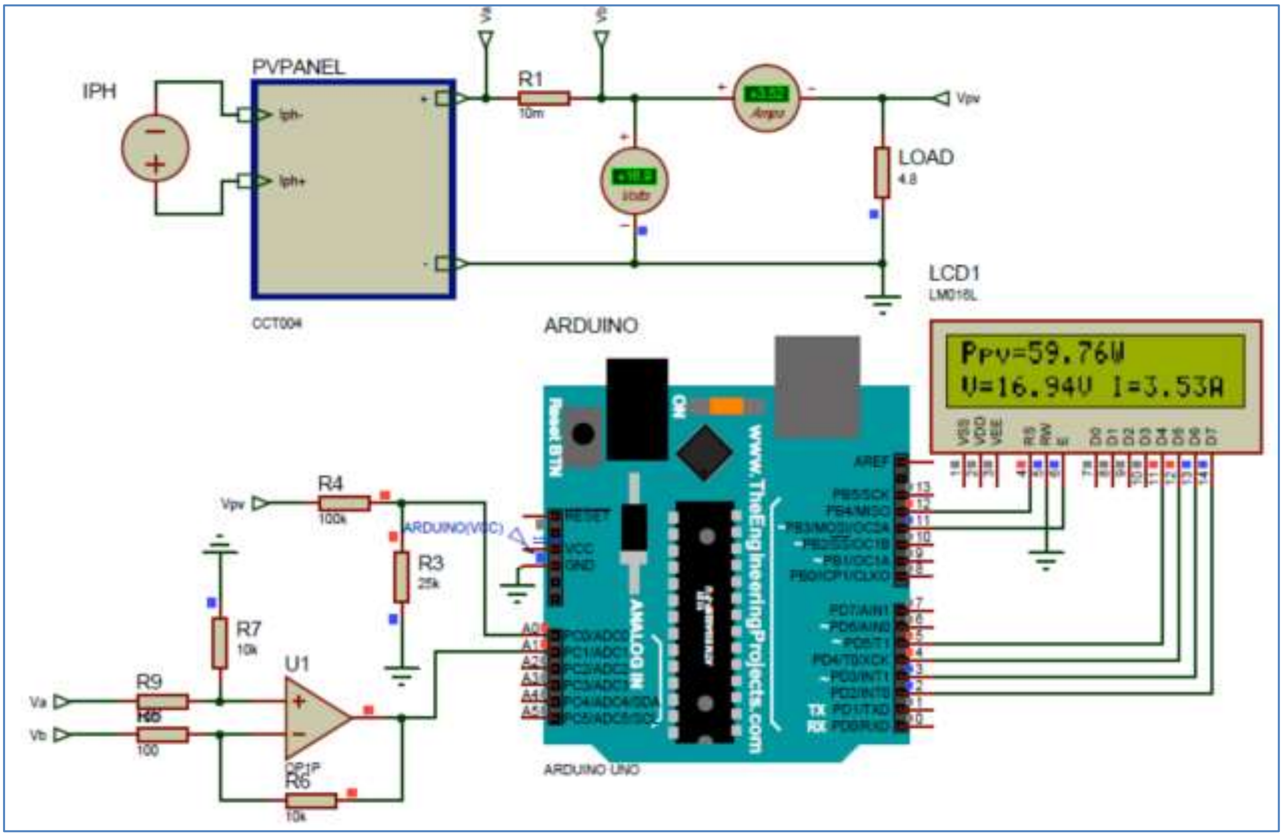


Fig.7.Solar Energy Measurement Using Arduino and Proteus

6. SIMULATION RESULT

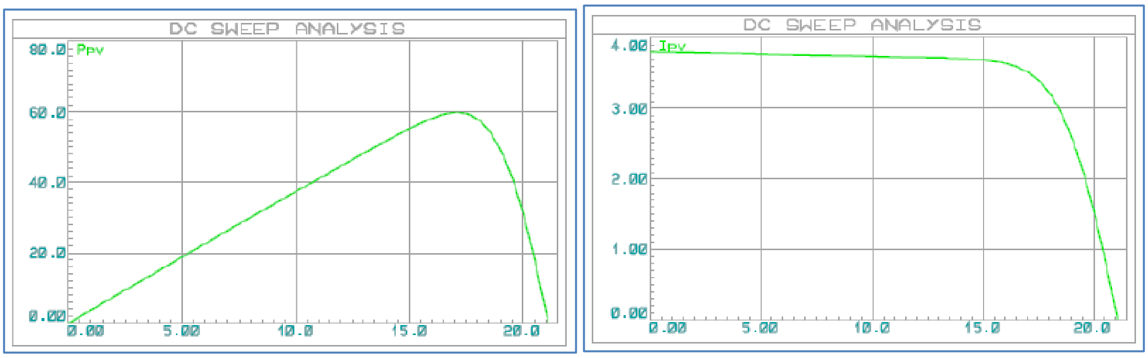


Fig.8.I-V and P-V characteristics for PV panel by using Proteus

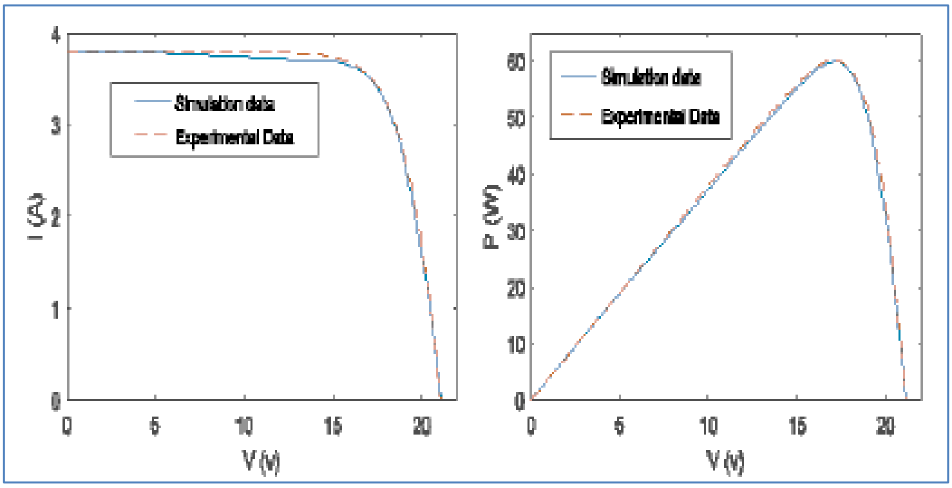
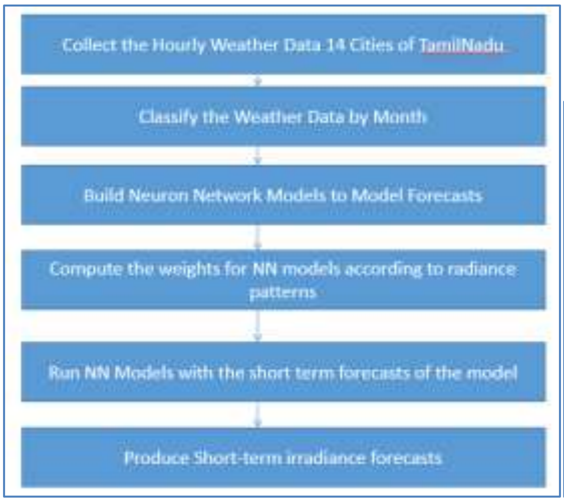


Fig.9.I–V and P-V model curves and experimental data

7. FORECASTING

This ANN Model provides scope for improving the accurate prediction in forecasting, describes a system which has been configured to meet the utility needs while addressing the Big Data issues. This ANN model improves the accuracy of forecasting by using disparate data, multiple models that are each applicable for a specific time frame, for both days ahead planning and real-time operations.



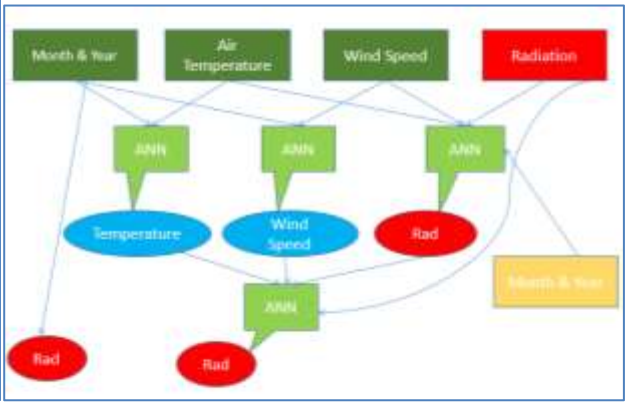


Figure 10 Data Flow Diagram Figure 11 ANN Proposed Model

Sl.No.	City Name	Latitude	Longitude	Atmospheric Pressure (kPa)	Wind Speed (m/s)
1	Madurai	9.8	78.10	73.34	5.3
2	Trichy	10.80	78.17	73.4	5.3
3	Salem	11.65	78.16	84.8	4.7
4	Vellore	12.91	79.13	84.8	4.7
5	Erode	11.35	77.73	73.2	5.0
6	Coimbatore	11.26	76.98	84.8	4.7
7	Tirunelveli	8.73	77.70	84.8	4.7
8	Thoothukudi	8081	78.13	86.3	3.4
9	Cuddalore	11.75	79.75	73.2	5.0
10	Kancheepuram	12.81	79.71	86.3	3.4
11	Dindugul	10.35	77.95	62.7	5.8
12	Tiruvanamalai	12.21	79.06	58.5	5.6
13	Thanjavur	10.80	79.15	65.0	5.0
14	Pudukkottai	10.38	78.81	65.0	5.0

Table 1 Input data to the model

7.1.1 Mean Square error

The Figure 7.1 shows that MSE become small as number of epochs (one complete sweep of training, testing and validation) are increased. The error of validation set and test set has similar characteristics and no significant over fitting has occurred by epoch 2 (where best validation performance has occurred).

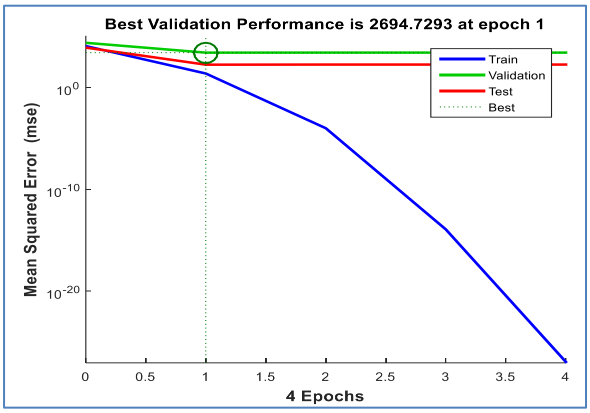


Figure 7.1 Mean Square Error

7.1.2 Error Histogram

The error histogram plot for training data is shown in Figure 7.2 to provide additional verification of network performance. It indicates outliers. The blue, green and red bars represent training data, validation data and testing data respectively. The most data fall on zero error line, which provides an idea to check the outliers to determine if the data is bad, or if those data points are different than the rest of the data set. If the outliers are valid data points, but are unlike the rest of the data, then the network is extrapolating for these points.

7.1 PERFORMANCE ANALYSIS

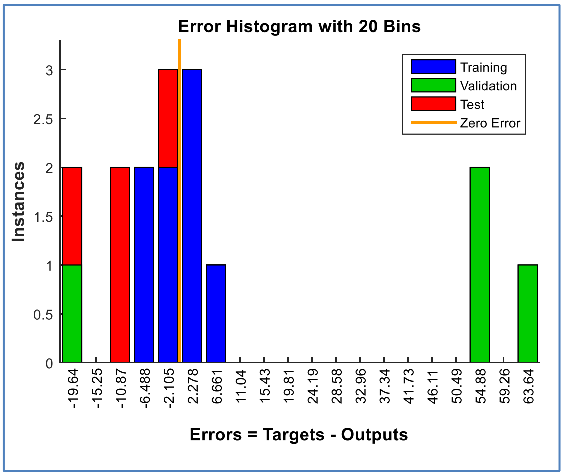


Figure 7.2 Error Histogram for Training data

7.1.3 The Correlation Coefficient (R-Value)

The correlation coefficient (R-value) measure the correlation between outputs and targets. R value of 1 and 0 means a close, random relationship respectively. The R value between the predicted and the actual values of monthly mean solar radiation are shown in Figures 7.3 for training, validation, testing and for the whole datasets and errors for training cities. R-values of 0.97, 0.93, 0.94 and 0.95 are obtained for the training, validation, testing and the whole dataset, respectively. This shows that nftool predicted solar radiation values are very close to the actual values for all the datasets.

Basically, the input data set was divided into three groups 15% was used for testing, next 15% are used validation and rest 70% was used for training of the network output results. The training data set is mandatory for attaining the neural network's weight and bias values during model training process. For systematically check the capability of the system the validation data set is needed to generalize. Lastly, the test data set is used in the evaluation of generalization error (i.e. MSE)

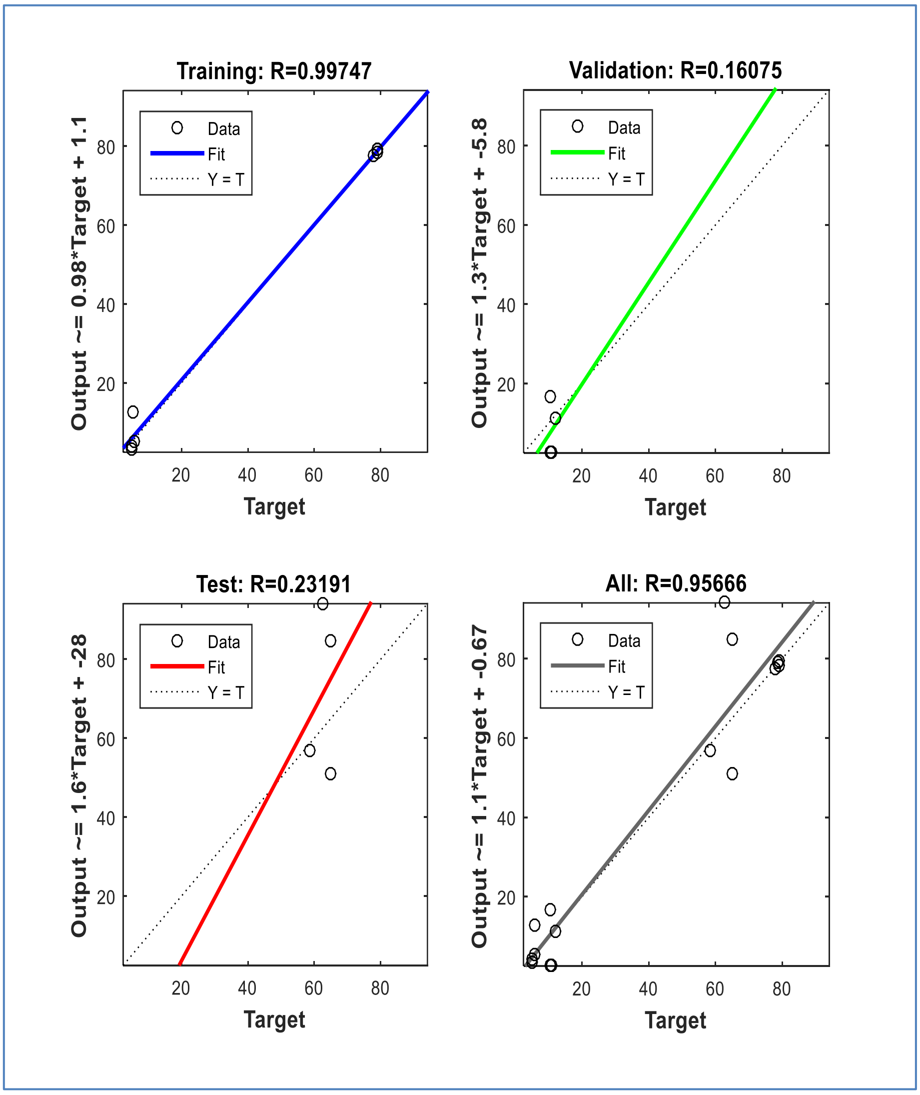


Figure 7.3 Training, Validation, Testing, Overall

8. CONCLUSION AND FUTURE WORK

At firstexplains in details the mathematical model for the PV cell, module and array. It was implemented and simulated using Proteus software. Dynamic system simulation studies demonstrate the effectiveness of all the physical and the environmentalparameters. Many graphs were presented to describe these effects which means this module can used for any type of PV system. This model can be used to study the environmental effects on the PV array at any expected installation area, identify the maximum power point tracking forthe MPPT, and study the shading effect on the specific PV array.

Second this paperdiscussed about the forecasting work done so far and about the future scope of work to be done for the phase-II. The results of this study indicate that the potential of Artificial Neural Network Fitting tool for prediction of solar radiation for identifying solar energy potential using longitude, latitude, atmospheric pressure and wind speed. From the analysis of results, it is found that the predicted values are in good agreement with measured values in Levenberg-Marquardt (LM) algorithm. Further, the present work confirms the accurate forecasting ability of ANN model dependence on the quantity and the variety of trained data in a particular application.

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Kiran Varade1, Ajay Rahane2, Akshay Dalvi3, Jitendra Bidgar4 1Assistant Professor, Electrical Dept., S.V.I.T, Chincholi, Nashik, Maharashtra, India

2,3,4B.E Student, Electrical Dept., S.V.I.T, Chincholi, Nashik, Maharashtra, India

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Subhash Kumar1, Dr. Tarlochan kaur2

ME Scholar, EED, PEC University of Technology, Chandigarh, India1Associate Prof., EED, PEC University of Technology, Chandigarh, India

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Pradesh, Indiab Energy Centre, Maulana Azad National Institute of Technology Bhopal, India
c Faculty of Mechanical Engineering, Universiti Malaysia Pahang, 26600 Pahang, Malaysia