iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VII **Month of publication:** July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36352

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Feed- Forward Neural Network based Day Ahead Nodal Pricing

Kaustubh Rokamwar[1], Prof. Pratik Ghutke[2]
[1, 2]*Department of Electrical Engineering, Tulsiramji Gaikwad Patil College of Engineering, Nagpur, India*

***Abstract:** An electricity locational marginal pricing prediction normally recognized by 24-hour day-ahead nodal price forecast. In this paper first collected all physical and technical data i.e. availability of generation and their cost characteristics, real and reactive demands at various buses, transmission capacity availability at various conditions like peak and off-peak conditions. All these input data are used as input for computation of optimal power flow. The nodal prices are calculated with AC-DC optimal power flow methodology for IEEE 30 bus system. The resulted optimal real electricity bus voltages, nodal prices, reactive and real demands, angles have been given as inputs to Artificial Neural Network (ANN) for predict day ahead nodal prices.*
***Keyword:** Artificial Neural Network, Optimal Power Flow*

I. INTRODUCTION

The restructured electricity market is to shrink the fee of electricity by way of antagonism. The adoption of compatible pricing mechanism and its forecasting system plays a major function to enhance competitors in an electrical energy promote. Precision in forecasting electricity costs is very decisive, in view that extra precision in forecasting reduces the peril of beneath or overestimating the proceeds from the mills for vigor companies and supplies better threat administration. Electrical energy nodal fee is a prediction of future electrical power fee situated on given previous prices and require, temperature, gasoline price and any other factors akin to monetary development, climate, historic costs and demand, anticipated energy shortfall, iteration outages [1][2]. Electrical energy rate is also pretentious with the aid of hour of the day, day of the week, season, and holidays. A excellent price forecasting process in electricity markets competent to seize the improbability associated with electricity fee. A quantity of price forecasting tactics were developed. These forecasting strategies can roughly be divided into two organizations [4]. The first one numerical approach also called hard computational systems established on the time-series mannequin, econometric mannequin and regression model. The 2d approach employs artificial intelligence methods often known as as gentle computational methods situated on the artificial Neural Networks and fuzzy systems to predict costs [6].

II. NODAL PRICE AND ANN PREDICTION

A. *Optimal Power Flow LMP Price*

The reactive and real price at unique bus where *i* is the Lagrange operate of the equality and inequality constraints viewed by way of fixing first order form of the Lagrangian, fractional derivatives of the Lagrangian with respect to each changeable worried. So the Lagrange function of equations are particular as a price perform

$$\begin{aligned} L &= \sum_{i=1}^{NG} (a_i P_{ig}^2 + b_i P_{iG} + c_i) + \sum_{i=1}^{NB} \lambda_{pi} (P_{di} - P_{ig} + P_{dci} + P_L) \\ &+ \sum_{i=NV+1}^{NB} \lambda_{qi} (Q_{di} - Q_{ig} + Q_{dci} + Q_L) \\ &+ \sum_{i=1}^{NG} \rho\, p_{li} (P_{ig}^{\min} - P_{gi}) + \sum_{i=1}^{NG} \rho\, p_{ui} (P_{ig} - P_{gi}^{\max}) \\ &+ \sum_{i=1}^{NG} \rho\, q_{li} (Q_{ig}^{\min} - Q_{gi}) + \sum_{i=1}^{NG} \rho\, q_{ui} (Q_{ig} - Q_{ig}^{\max}) \\ &+ \sum_{i=1}^{NB} \rho\, v_{li} (|V_i^{\min}| - |V_i|) + \sum_{i=1}^{NB} \rho\, v_{ui} (|V_i| - |V_i^{\max}|) \\ &+ \sum_{i=1}^{NB} \rho\, \delta_{li} (\delta_i^{\min} - \delta_i) + \sum_{i=1}^{NB} \rho\, \delta_{ui} (\delta_i - \delta_i^{\max}) \\ &+ \sum_{i=1}^{Noele} \rho\, p_{fli} (P_{fi}^{\min} - P_{fi}) + \sum_{i=1}^{Noele} \rho\, p_{fui} (P_{fi} - P_{fi}^{\max}) \end{aligned} \quad (1)$$

©IJRASET: All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Where, w= (w_i,…,w_n) is is the vector of Lagrange multipliers concerning equality constraints;; ρ = (ρ_1,…,ρ_n) are the Lagrange multipliers as regards to inequality constraints. An optimal solution (x, w, ρ) for a set of given (P, Q). Nodal cost of real and reactive energy for bus is expressed for $i = 1---n$

$$\pi_{p,i} = \frac{\partial L(X, w, \rho, P, Q)}{\partial_{pi}} = \frac{\partial f}{\partial_{pi}} + w\frac{\partial S}{\partial_{pi}} + \rho\frac{\partial T}{\partial_{pi}} \quad (2)$$

$$\pi_{q,i} = \frac{\partial L(X, w, \rho, P, Q)}{\partial_{qi}} = \frac{\partial f}{\partial_{qi}} + w\frac{\partial S}{\partial_{qi}} + \rho\frac{\partial T}{\partial_{qi}}$$

The difference ($\pi_{p,i} - \pi_{p,j}$) represents real transmission amount from one bus to another. are the constitution marginal price shaped through an increment of actual and reactive power load at bus correspondingly.

B. Artificial Neural Network

Synthetic neural networks have been generally utilized in many cost and demand prediction troubles. The main intent for their success is that they are complete of supplying excellent solutions, to form elaborate nonlinear relationships a lot better than the other based linear models. A neural community is a regular crew of artificial neurons that uses a mathematical for information processing headquartered on a connectionist transfer towards to computation. ANNs are incredibly unified processing items prompted within the human brain and its exact finding out process. Interconnections between items have weights that multiply the values which go by way of them. Additionally, items quite often have a fixed input called bias. Each and every of those units forms a weighted sum of its inputs, to which the bias is delivered. This sum is then handed by means of a switch perform [9].

In the finding out approach, a neural network constructs an enter output mapping, adjusting the weights and biases at each iteration founded on the optimization of some error calculate between the output produced and the desired output. This system is conventional unless an enough criterion for junction is reached [10].

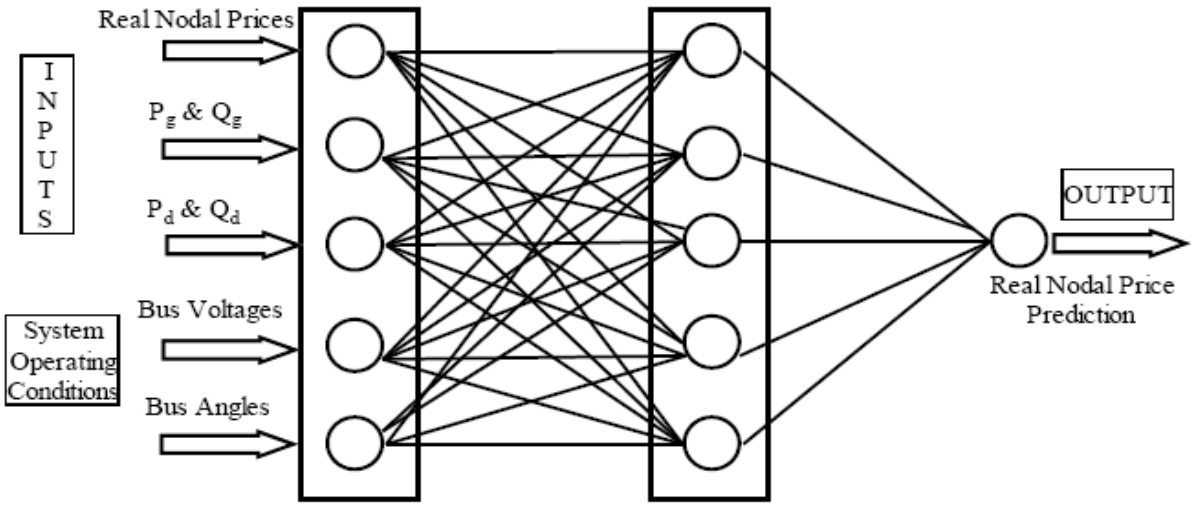


Figure 1: Neural Network model for nodal price prediction

A quantity of neural networks like Feed-forward Neural community (FFNN) with back-Propagation (BP) algorithm, Cascade Feed-forward Neural network (CFNN), Generalized Regression Neural network (GRNN), Radial Basis Neural Network (RBNN) and Exact Radial Basis Neural Network (RBENN models to foretell day-ahead electrical power nodal costs. The structure and modelling of these neural networks are explained beneath.

©IJRASET: All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Feed-forward neural network is viewed with n,m and q neurons for the input, hidden and output layers, respectively. The enter patterns of ANN represented by way of a vector of variables x = (x_1, x_2, . . x_n) given to neural community by using enter stage are transferred to hidden layer. The load of connection between input and hidden layer and the bias of hidden layer, the output vector u = (u_1, u_2, . . . u_m) of the hidden layer is corporation. Output u_p of neuron j is observed as

$$u_p = \varphi hod\left(\sum_{i=1}^{N} w_{ji}^{hod}\ x_i + b_j^{hod}\right) \quad (3)$$

Where w_{ji}^{hod} is the weight of organization between neuron *j* in hidden layer and the *i*-th neuron of input layer, b_j^{hod} used the fondness of neuron *j* and φhid is the activation perform of hidden layer. Specification of the vector *u* of hidden layer is handed to output layer. Using weight of the link between hidden and output layers and the bias of output layer, output vector *y* = (y_1, y_2, . . . , y_k, . . . , y_Q) of the output layer is finalized.

The result output y_k of neuron *k*

$$y_q = \varphi oyt\left(\sum_{j=1}^{M} w_{jk}^{oyt}\ u_j + b_k^{out}\right) \quad (4)$$

Where w_{jk}^{oyt} is weight between neuron *k* in output layer and the *j*-th neuron of hidden layer.

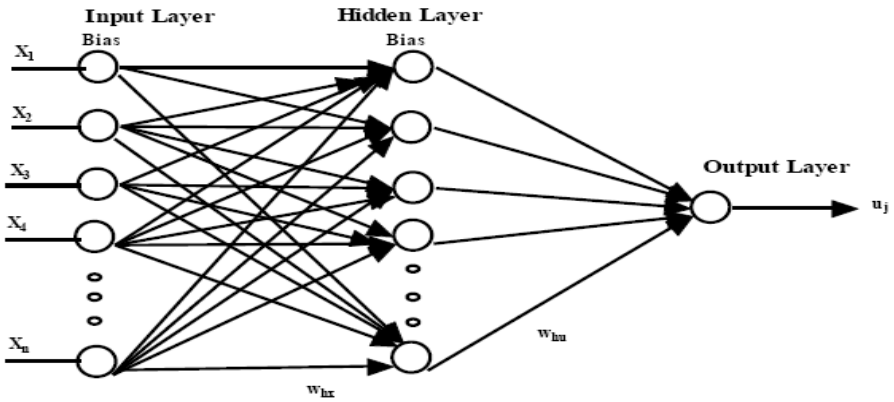


Figure 2: Feed Forward neural network of three layers

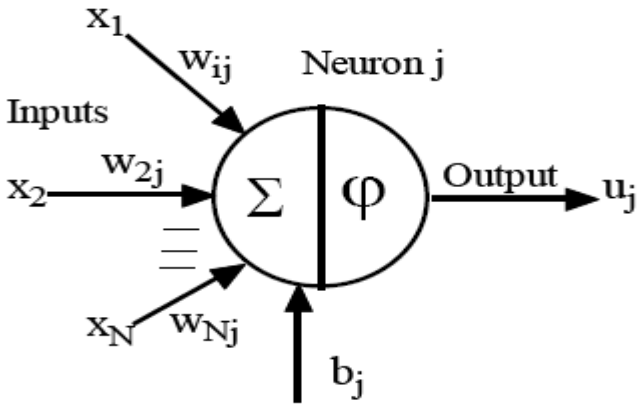


Figure 3: Information providing in a neural network

©IJRASET: All Rights are Reserved

III. PERFORMANCE AND MEASUREMENTEVALUATION OF ELECTRICITY NODAL PRICE PREDICTION

Significant problem in ANN request is the variety of performance assessment function. For the principle of quantifying out-of pattern prediction potential of the brand new model, the electrical energy spot price prediction is formulated and precised by means of utilising root imply rectangular error (Rmse), mean absolute percentage error (Mape), error variance, normal Deviation (Sd) and Forecast imply square Error (Fmse). The most commonly used function is Rmse and it is calculated by

$$Rmse = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Nodal\ \Pr ice_{predicted} - Nodal\ \Pr ice_{real})} \quad (5)$$

Mape has been adopted as the accuracy criteria to evaluate and balance the solution of various parts. It is represented by

$$Mape = \frac{100}{N}\sum_{i=1}^{N}\frac{|Nodal\ \Pr ice_{predicted} - Nodal\ \Pr ice_{real}|}{Nodal\ \Pr ice_{real}} \quad (6)$$

Strength of the given input measured by means of statistical index The error variance (γ^2) is represented by

$$\gamma^2 = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{|Nodal\ \Pr ice_{predicted} - Nodal\ \Pr ice_{real}|}{Nodal\ \Pr ice_{real}} - Mape\right)^2 \quad (7)$$

Other Fmse,

$$Fmse = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Nodal\ \Pr ice_{real} - Nodal\ \Pr ice_{predicted})^2} \quad (8)$$

Standard deviation (Sd) is widely applicable for measurement of variability or diversity used in statistics and probability theory. It is a measure of data dispersion from its average. Major apart the value, higher will be the deviation

$$Sd = \gamma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{|Nodal\ \Pr ice_{predicted} - Nodal\ \Pr ice_{real}|}{Nodal\ \Pr ice_{real}} - Mape\right)^2} \quad (9)$$

This paper calculates the errors and compares with various neural network models used to predict electricity nodal price.

IV. STATISTICAL RESULTS

The optimal power flow methodology is faux for IEEE 30 bus system process for day-to-day usual height real and reactive power needs at distinct buses. The calculated bus angles, voltage and real electrical power spot prices are proven in table 1.To forecast the day forward electrical power spot costs, the input variables stated and assigned to more than a few neural systems and inputs are elected as proven in table 1. All of the neural inputs attended extra specified nodal rate prediction.

Bus No.	Average Nodal Price for various Demands	
	AC-DC OPF	FFNN Prediction
1	19.21	19.19
2	19.26	19.23
3	19.28	19.25
4	19.30	19.28
5	19.46	19.43
6	19.35	19.33
7	19.40	19.38
8	19.36	19.37
9	19.38	19.36
10	19.40	19.39
11	19.38	19.36

©IJRASET: All Rights are Reserved

12	19.23	19.21
13	19.23	19.21
14	19.29	19.27
15	19.22	19.20
16	19.32	19.30
17	19.39	19.37
18	19.36	19.35
19	19.42	19.41
20	19.41	19.39
21	19.46	19.43
22	19.36	19.34
23	18.99	18.95
24	19.13	19.11
25	18.75	18.73
26	18.63	18.61
27	18.60	18.59
28	19.35	19.33
29	18.76	18.72
30	18.81	18.80

Table 1 Comparision result of real node price with FFNN predicition

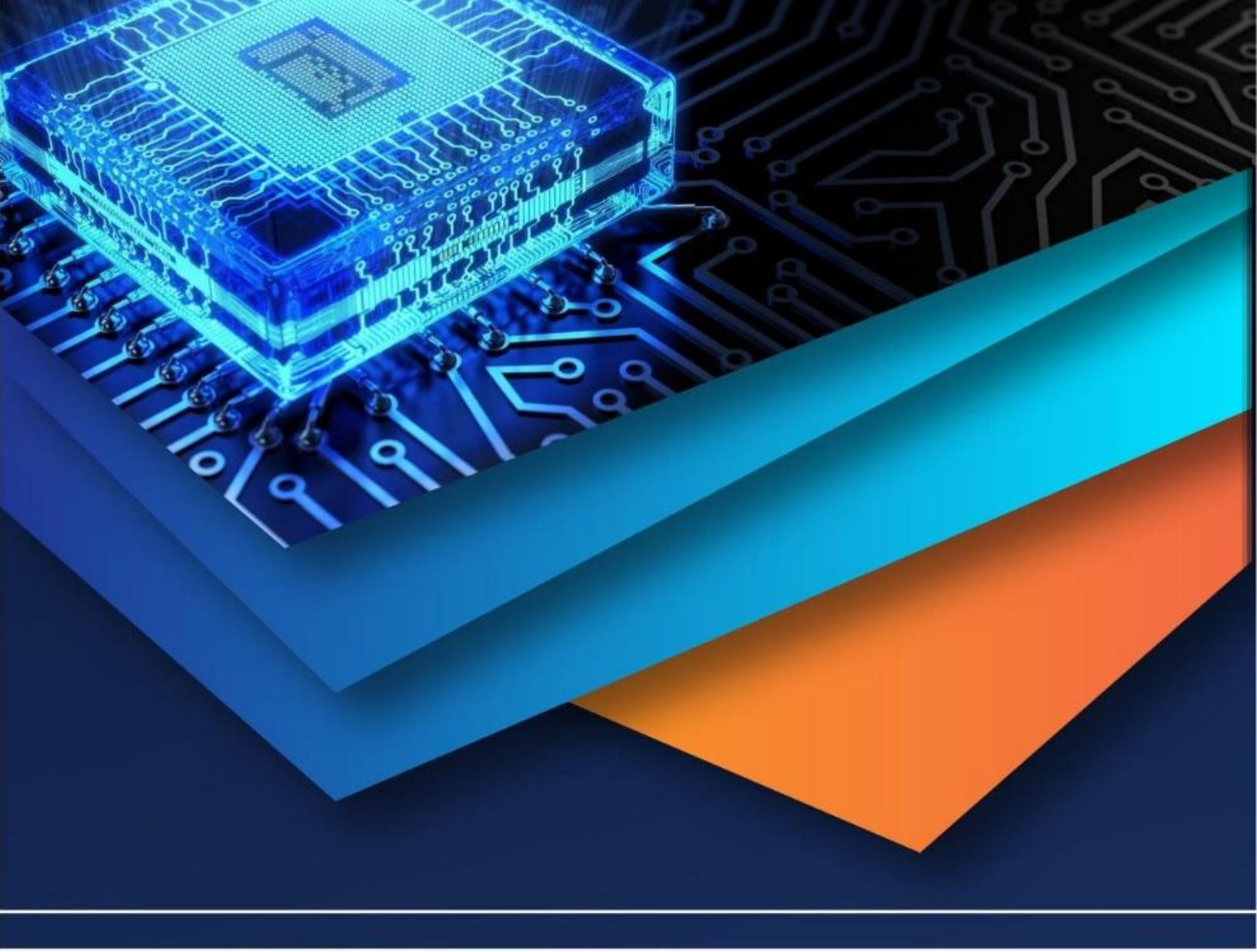
V. CONCLUSIONS

This paper projected AC- DC situated methodology and FFNN to predict day ahead spot prices. This methodology is used on IEEE 10 bus system and outcomes are calculated. This paper duly used to admire forecasting errands, given its potential of simulating multipart and nonlinear method, and its capacity to prediction. FFNN wishes the shrink quantity of calculation for low MSE for group. This improvement is most of the time visible for proper worth level is indispensable. The spot pricing of every nodal prediction are correct ample to be used by market contributors to estimate the danger of rate instability in spot market, to make certain money restoration and to foretell movements of market vigour and so on.

REFERENCES

[1] R., Nogales, F. J., and Conejo, A. J. ARIMA models to predict nextday electricity prices.
[2] M. A., Espinola,R. and Molina, A. B. Dayahead electricity price forecasting using the wavelet transform and ARIMA models. IEEE Transactions on Power System,20 (2), 2005, 1035 1042.
[3] J., Akkeren, M. and Garcia, J. B. C. A GARCH forecasting model to predict day ahead electricity prices. IEEE Transactions on Power System,20 (2), 2005, 867–874.
[4] Chen L. Next-day electricity-price forecasting using ahybrid network. IET Generation Transmission Distribution,1 (1), 2007, 176-182.
[5] Ching,Mattson, Chris and Lawarrée, J. Day-Ahead Electricity Price Forecasting in a Grid Environment. IEEE Transactions on PowerSystem,22 (1), 2007, 266–274.
[6] Pavlos S., Georgilakis Artificial Intelligence solution to electricity price forecasting problem. Journal of Applied Artificial Intelligence,21 (8), 2007, 707-727.
[7] Rodriguez, C. P. Energy price forecasting in the Ontario competitive power system market. IEEE Transactions. on Power System,19(1), 2004, 366–374.
[8] Zhang, L. Neural network-based market clearing price prediction and confidence interval estimation with an improved extended Kalman filter method. IEEE Transactions on Power System,20 (1), 2005
[9] A.K., and Park, Jung Wook. An Effort to Optimize Similar Days Parameters for ANN Based Electricity Price Forecasting. IEEE Transactions on Industry Applications, 45 (5), 2009
[10] S.Warkad ,M.K.Khedkar,AC-DC OPF based Day-Ahead Electricity Nodal Price Prediction using an ANN I.J.C.A Vol.9-N0.10,Nov.2010
[11] V.G.Umale and S.B.Warkad "Day Ahead Electricity Transmission Price Prediction using FFNN" Journal of Advance Research in Dynamical & Control Systems(JARDCS) ISSN-1943-023X Vol. 10, 02 pp. 13791385 -Special Issue, 2018

©IJRASET: All Rights are Reserved



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)