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Optimization of Parameters in the Energy Sector by Means of ANN

Harikrishnan R
Assistant Professor
Department of Mechanical Engineering
College of Engineering and Management, Punnapra, Kerala, India
Email id: *- harikr24jan@gmail.com*
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Abstract

In the Energy sector, many parameters are involved for obtaining the transmission and distribution of Power process, efficient and effective by reducing various power transmission and distribution losses. The parameters concerning Energy are interdependent and relatively close together in various aspects. The parameters such as Cost of Energy production, Plant capacity, Efficiency of Power production etc., are interdependent. They can be related to two variables such as independent variables and dependent variables. Optimization of these parameters is being carried out with the help of an Artificial Neural Network. Maximum error formed in the relationship can be found out and is easily be reducible. An analysis is being made in the optimization model using ANN.

Keywords*: - Power Transmission, Artificial Neural Network, Energy Cost, Energy sector, Signum Function, Gradient Descent.*

INTRODUCTION

The World's second-largest populated country, India, has more than 121.5 Cr. people officially and has 17.5% of the World's population. Being the seventh-largest country globally, it lies in the Indian subcontinent with an overall land area of 3,287,270 sq kilometers. The nation India extends along 3215 km from north to south and 2995 km from east to west. This nation has a huge land area of 15,300 km and a coastal belt of 7,600 km. Indian union has 29 states and 7 union territories. It embarks upon a formidable consequence for providing adequate energy supplies to users at a reasonable cost. This vast nation India's nominal GDP will be exceeding day-to-day as compared to developed countries like France, Germany, UK, US etc. India's nominal Gross Domestic Product has crossed the annually growing nominal GDP rate during the period and is around 23 percent.

Thus, in Indian union states and territories, the people's energy provision has become a major challenge. For the last six decades, India's energy usage has increased to 20 times and the installed electrical power production capacity by 90 times. Rightly In 2014, India's energy usage was the fifth highest in the World. More than that, India is suffering from significant energy scarcity in large and obviously electricity deficits. During recent years, India's energy consumption rate has been increasing rapidly due to an increase in population and overall development. Anyway, the base rate may be somewhat at a low level. Indian economy is projected to grow at 9-10% per annum, abrupt changes in the economy to urbanization, and improving living standards for millions of Indian people. The demand is surely growing significantly.

Energy's supply chain is of such extent that more logically severe apprehensions can occur due to shortages of Energy. Increasing the demand for Energy and meeting the supply chain's demand within the current position is inevitable. The problem of power shortage due to losses in the distribution network and transmission system, Cutting-off of light, and Load Shedding in the Indian Power and Energy Scenario in Rural and Urban India is a major setback the Energy sector in India. Enhancing this Energy scenario with a Green and eco-friendly Environment is helpful if Non-conventional Energy Source can be an option against this and provides a big challenge.

Neural networks are the simplified models of the biological neuron system. It is a massive parallel distributed processing system made up of highly interconnected neural computing elements. They can learn and thereby acquiring knowledge and also making it available for use. The artificial technology that has been built on a simplified imitation of computing neurons of a brain has been termed as ANN or Artificial Neural Network.

An artificial Neural Network is defined as a data processing system. It consists of a large number of simple, highly interconnected processing elements (artificial neurons). It is assembled like architecture inspired by the structure of the cerebral cortex of the brain.

In this research paper, ANN is used to optimize the parameters in the Energy sector. Thus, optimizing these energy-related parameters makes it possible to get accuracy in calculations and avoid potential errors in other assisted parametric calculations.

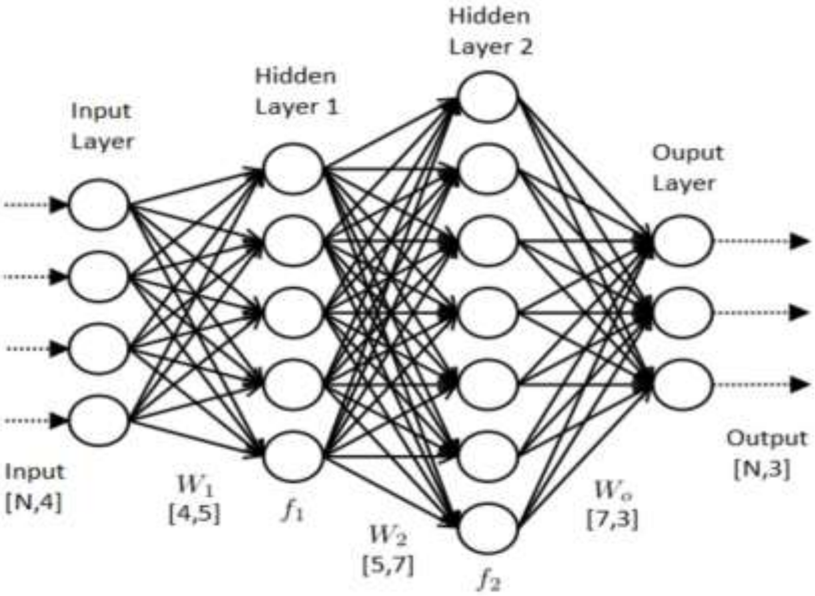


Figure 1: ANN

COMPARISON OF PARAMETERS OF ENERGY SECTOR

TABLE 1

ENERGY SOURCES	Nominal Capacity (MW)	Current cost on KW	Effectiveness	Anticipated costs on KW
Natural Gas	620	917 USD	90%	1019 USD
Coal	650	3246 USD	90%	3607 USD
Hydropower	500	2936 USD	75%	3915 USD
Nuclear Energy	2234	5530 USD	90%	6144 USD
Wind Energy Terrestrial	100	2213 USD	25%	8852 USD

Biomass	20	8180 USD	90%	9089 USD
Wind Energy Offshore	400	6230 USD	35%	17800 USD
Solar Energy PV	150	3837 USD	20%	19365 USD
Solar Energy Therm o-electric	100	5067 USD	30%	35335 USD

TABLE 2

Energy Carrier	**Current Installed Capacity(MW)**	**Targeted Installed Capacity(MW)**	**Cost of 1 MW (USD)**	**Complete Renewable Energy Transmission cost (USD)**
Wind Turbines	3	3206	8852000	28349415200
Geothermal	132	200	3319000	225692000
Hydroelectric	1653	1653	3319000	0
Roof Solar PV	543	3372	19365000	54791331000
Solar PV Power Plants				
OVERALL	2331	8431	-----	83366438200

TABLE 3

Source of Energy	**Global Energy Potential** (in trillion watts)	**Availability in economically effective area (in trillion watts)**
Wind	1750	45-90
Wave	2.9	0.7
Geothermal	48	0.08-0.15
Hydroelectric	1.95	1.8
Tidal	3.9	0.03
Solar PV	6600	345
Direct Sunshine	4650	245

OPTIMISATION DESIGN

The Neural network model is

I= ΣWiXi + Bk

I=W1X1+W2X2+W3X3+………+ WnXn

I_1=620X1+650X2+2500X3+2234X4+100X5+20X6+400X7+150X8+100X9

I_2=917X1+3246X2+2936X3+5530X4+2215X5+8180X6+6230X7+3837X8+5087X9

I_3=0.9X1+0.9X2+0.75X3+0.9X4+0.25X5+0.9X6+0.35X7+0.25X8+0.7X9

I4=1019X1+3607X2+3915X3+6147X4+8852X5+9089X6+17800X7+19365X8+35335X9

Bk1=600
Bk2=1000
Bk3=0.75
Bk4=1500

Here we can undertake relationship between functions and its variables.

I4 is a function of (I1+I2+I3)

Simplifying we get,

519X1+1335X2+5397X3+1618X4-6836.75X5-888X6-11170X7-15378X8-30148X9=101

For optimization, putting all the variables equal to 0, 0.1, 0.01, 0.02, 0.001 we get values as 101, -5629.1,-552.91,-602.72,-55.291

Dividing throughout by 5700, we get values as 0.0097, 0.097, 0.105, 0.987 and 0.177

Therefore the input values are 0, 0.1, 0.01, 0.02 and 0.001.

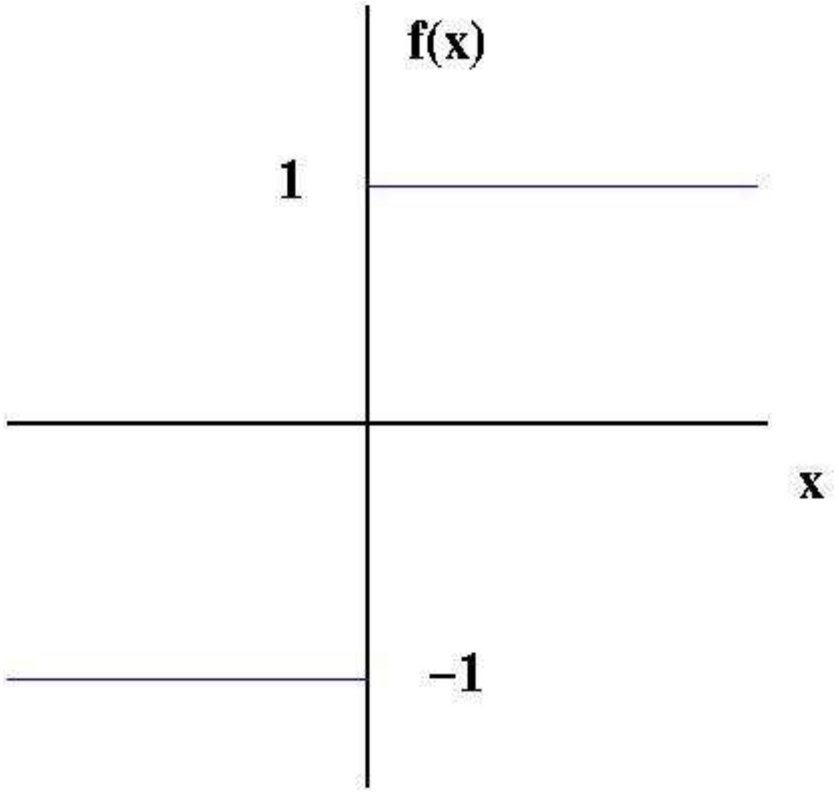
The output values are 0.0097, 0.097, 0.105, 0.987 and 0.177.

Obtained Value, O= (0.5×0.0097-0.4×0.097+0.2×0.105+0.1×0.987+0.3×0.177) = 0.13885

Error function, E= ½((T-O)^2)=1/2((1-0.13885)^2) =0.3707

Gradient, ƏE/ƏWoi = -(T-y)Xij = -(1-0.097)0.1 = 0.0903

Vk>=0, Yk=1



Vk<1, Yk=-1

Figure 2: Signum Function

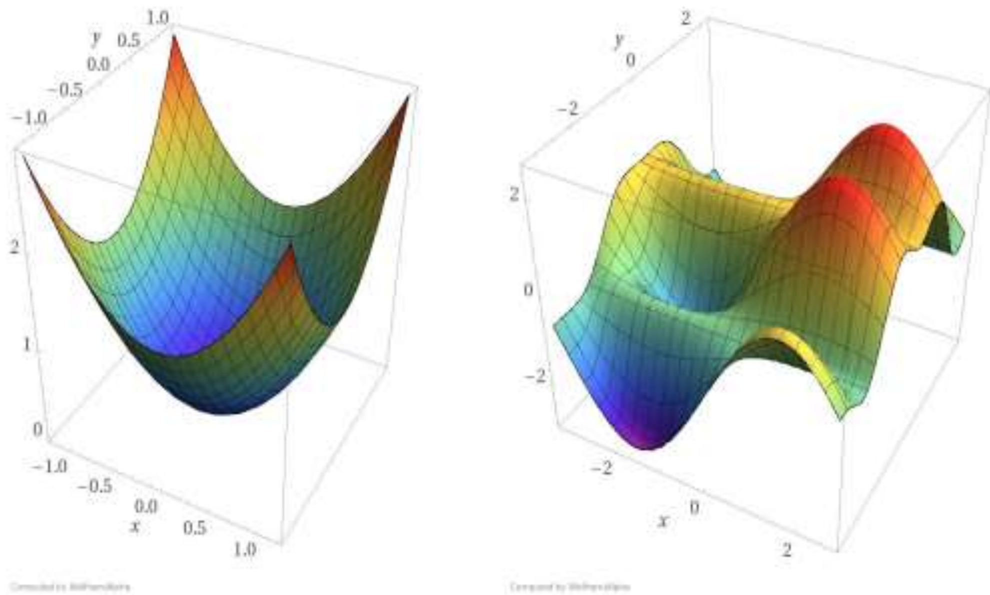


Figure 3: Gradient Descent

CONCLUSION

ANN of a set of values consisting of different parameters for the Energy sector is being analyzed. A model neural network equation was defined with the independent variable as Anticipated cost in kW for power production and dependent variables as nominal capacity in MW, Current cost in kW, and power production efficiency. After simplifying, an ANN equation in the form ΣaiXi + Bk was formed.

The optimization has been done by inputting five sets of values to the variables. The target value and values obtained are noted. The error function is obtained as E=1/2((T-O) ^2).

The steepest error obtained is 0.0903. The possibilities of accurate values are obtained with the analysis of error function and Gradient descent. A signum function is drawn with input and output values. From all these findings, it can be considered as a very good optimization model.

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