

Computer Science

ARTIFICIAL NEURAL NETWORK FOR LONG TERM LOAD FORECASTING **IN UTTARAKHAND STATE: A CASE STUDY**

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ABSTRACT Electricity is one of the essential part of our life. With the increase in consumption of resources the demand of electricity is also increased. Uttarakhand as hilly state is approaching towards implementation of new Technologies and Techniques in the area of growth and suistainable development. Due to the implementation of better road infrastructure, tourism connectivity and IoT devices in various projects and inclusion of electric vehicles and their charging infrastructure in Uttarakhand State the demand of electricity has also increased. The Uttarakhand State has planned the establishment of new infrastructure by providing relaxation on various taxes and option of subsidy to investors. The exemption on fixed electricity charges is provided to investors in Uttarakhand. The highest part of Electricity Generation is based on Hydro Power in Uttarakhand. By establishment of new infrastructure in Uttarakhand it would be a thrust to load generation companies to produce demanded of electricity on time. In this study the long-term load forecasting from 2022 to 2030 is analysed using Artificial Neural Network. The input data is received from Uttarakhand Electricity Regulatory Commission and Uttarakhand Power Corporation Limited. The prediction is based on last 10 years data of historical load, GDP, Population, and past two years data of electric vehicles, and charging infrastructure. In this study, it has reported that by 2030 there would be huge change in infrastructure and most of diesel and petrol vehicles would come on electric vehicles. This study is focused on the Long-Term Load Forecasting in Uttarakhand State where electric vehicles and charging infrastructure load requirement is also calculated. Using Deep Learning Technique in this paper Artificial Neural Network is used for forecasting the results. This tool is used to identify the consumption pattern of electricity in Uttarakhand State for further nine years from 2022 to 2030. The Government of Uttarakhand has planned Vision 2030 for the sustainable development in Uttarakhand.

KEYWORDS : ANN, IoT, GDP, Forecasting.

INTRODUCTION

Uttarakhand State was formed on 9th September, 2000 which is surrounded by snow covered mountains connected with Char Dam Yatra Points included Yamnotri, Gangotri, Kedarnath and Badrinath. The State has thirteen districts connected with Nepal Border, Himachal Pradesh, Punjab and Uttara Pradesh. There are three Power Distribution Companies in Uttarakhand namely Uttarakhand Jal Vidyut Nigam Limited, Power Transmission Corporation of Uttarakhand Limited and Uttarakhand Power Corporation Limited which are the bone marrow of electricity sector of Uttarakhand. In 2011 the Population in Uttarakhand was 10086292 and in 2020 it is 11436292 as per census record. Similarly the demand electricity in 2020 was 12556.69 MU and 2021-22 is 14969 MU. Since the inception of Uttarakhand State the Government has tried to attactract investors by promoting various schemes. Presently there are Hydro, Solar Roof Top, Biogas based generation stations in Uttarakhand. The Consumption pattern in Uttarakhand has gradually decreased due to Covid-19 impact. The Energy Generation Companies has faced the loss in revenue generation due to sudden shut down by various companies in Covid-19. At present the Government of India and Government of Uttarakhand has announced the shortage of electricity due to rise in price in energy exchange by three times.

OBJECTIVES

The aim of this study is to forecast long term load requirement in Uttarakhand State which includes Hydro Power, Gas Based, Solar Roof Top and Renewal Energy Sources, Electric Vehicles and Charging Infrastructure from 2022 to 2030.

STUDYAREA

In the present study, the Uttarakhand State is chosen as study area where main emphasis is to forecast the future electricity load requirement till 2030. Government of Uttarakhand has also planned vision 2030 for sustainable development and to promote various investors to establish industry hub in Uttarakhand.

DATA

The Table 1 represents the data collection of GDP, Population and Energy Demand from 2012 to 2020 which is collected from Uttarakhand Electricity Regulatory Commission and Uttarakhand Power Corporation Limited. In Uttarakhand there is one Power Regulatory Organisation known as Uttarakhand Electricity Regulatory Commission and three Power Utilities companies namely Uttarakhand Jal Vidyut Nigam Limited (UJVNL) for Generation of

Power, Power Transmission Corporation of Uttarakhand Limited (PTCUL) for Transmission of Power and Uttarakhand Power Corporation Limited (UPCL) for Distribution of Power among all consumer categories in Uttarakhand.

Table – 1 Energy Demand In Uttarakhand

Year	Energy Demand	GDP	Population
2012	8577.01	1.32	10236292
2013	9065.02	1.49	10386292
2014	9685.16	1.61	10536292
2015	10298.14	1.77	10686292
2016	10571.69	1.95	10836292
2017	11208.82	2.23	10986292
2018	11826.68	2.46	11136292
2019	12021.35	2.69	11286292
2020	12556.69	2.51	11436292

Source: UERC and UPCL, Uttarakhand

METHODOLOGY

In this study Artificial Neural Network (ANN) method is used to analyse Long Term Load Forecasting for State Utilities of Uttarakhand using new approach. Artificial Neural Network is a part of Artificial Intelligence which is a new generation of information system that has the capability to learn, recall and generalise from the pattern of training data. The neural network consists of large number of simple processing elements called neurons or nodes. Every neuron is connected to other neuron having associated weight. This weight is used to simplify the problems. Each neuron has an activation, which is a function of the inputs it has received. A neuron sends signal to several other neurons. In this study Population, GDP and Load data including last two years load data of electric vehicle and charging infrastructure is collected from 2012 to 2020.

- A. Process of load forecasting ANN technique
- Data Collection: The first step is data collection process into ANN.
- Data Pre-Processing: As the data collected the next step is to clean the data using data cleansing remove unformatted data and arrange data in valid order and fill up missing data.
- Building the network: In this section the number of hidden layer is defined including neuron and transfer function in each layer and

training function and learning function where multilayer perception is used. In Figure 1 simplified 3-layer feed forward network is mentioned.

- Training the network: In this section the network is trained, and weights are adjusted in order to make the actual output near to the target output of the network. 70% data is used for training the network
- Validation of network: After the training 15% data is provided for validating the network.
- Testing the network: After validation the 15% data is used for testing the network where future forecast is calculated.

The below mentioned three-layer feed forward neural network is used to calculated long term electricity load forecasting from 2022 to 2030.



Figure 1: Three Layer Feed Forward Network

Sources: https://a-eie.uonbi.ac.ke

B. Mean Absolute Percentage Error

$$M = \frac{1}{n} \frac{\sum x_a - x_f}{x_a}$$

Where X_a: Actual Value X_f : Yearly load demand

RESULTS

In this study three layered feed forward network is used using Artificial Neural Network. The Figure 2 depicts that the requirement of electrical load is gradually increasing after 2027 to 2030. As the Government is planning for charging infrastructure and electrical vehicles in Uttarakhand the requirement of electrical load would also increase. The MAPE calculated 0.04 as minimum and 0.78 as maximum.



Figure 2: Load Forecasting Demand for 2022 to 2030

Sources: MATLAB Analysis Results

CONCLUSION

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This study can help power regulators and generation companies of Uttarakhand to determine the future load requirement as the future is

going to be dependent on electricity mobility. Time of Day tariff can be planned by distribution companies to generate more revenue. Future Load curve 2022 to 2030 can help to enhance power capacity of generation stations in Uttarakhand.

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