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Research Article

Classification by Artificial Neural Network according to the values affecting Electricity Generation

Abstract

Predicting the amount of electricity produced in a power plant is very important for today's economy. Oven Power (MW), Boiler Input Gas Temperature, Superheated Steam Amount, ID-Fan Speed, Feeding Water Tank data affect the electricity production. In this article, Etikrom A.Ş. The electricity production amount to be produced in Elazığ Etikrom A.Ş. was estimated by using the data of Oven Power (MW), Water Inlet Gas Temperature, Steam Vapor Volume, ID-Fan Speed, Feeding Water Tank data. Electricity generation amount is used as verification data. That is, by the k-means clustering method, the electricity generation amount is divided into 3 classes (low, medium, and high). 3621 data including Oven Power (MW), Boiler Input Gas Temperature, Superheated Steam Amount, ID-Fan Speed, and Feeding Water Tank data were used after class 3 separation. With the K-means clustering method, 2742 of these data were clustered as low electricity, 296 as medium electricity and 583 as high electricity. This clustered data was given to the Artificial Neural Network classifier. The success rate obtained as a result of this classification is 85.81%. Classified data were analyzed by ROC curve.

Introduction

Nowadays, various sources are used to meet the need for electricity. One of the ways to meet energy needs is electricity generation with steam. Steam is the passage of water through various stages and from liquid to gas. In this article, we describe the transformation of electricity to electricity by generating steam and we have examined and classified the variables that affect the electricity production values and production values. The data belong to the year 2017 and are registered for every hour. We have ETİKROM A.Ş. by observing the data we have observed in the cogeneration plant, we have observed by classifying variables affecting electricity generation and electricity generation. In a steam power unit; high pressure steam boiler, high pressure steam turbine, condenser, feed water tank, superheater. In the demineralization unit, water with a maximum of 0.2 μ S conductivity and a minimum pH of 9.4 is sent to the feed water tank.

The water temperature in the feed water tank is increased a little. Burning of the arc furnaces with 23 MW installed power, which is used to melt the chrome, is taken into the boiler by vacuuming with the help of the resulting flue gas ID-Fan. Water is circulated through the boiler with the help of pipes. Boiler; high pressure economizer, high pressure evaporator, high pressure superheater, high pressure steam drum. The

water in the pipes is interacted with the reverse flow by the gas taken in. The steam obtained as hot steam in the boiler is taken to the high pressure steam drum. The pressurized steam is sent from the high pressure steam drum to the steam turbine. The steam sent to the steam turbine is hot. Steam with 300 °C and 30 bar pressure is hot and steam turbine is sent to these specifications. Convection steam is condensed in the condenser and the condensate is pumped back to the feed water tank by the condenser pumps and the closed cycle is completed.

In addition, the feed water tank is kept warm continuously. This is possible by constant steam heating from the high pressure steam boiler. The harmful and suspended substances in the system are taken out by the bluff tank. Synchronized generator with steam turbine is operated and electricity generation is provided. The amount of electricity produced depends on some variables, from steam production, steam to the steam turbine, and the synchronous generator connection of the steam turbine with the help of reducers. These variables are the oven power, the boiler gas inlet temperature, the total amount of steam produced, the feed water tank temperature elevated water temperature, the ID fan speed, and the ambient temperature. If these variables are to be explained, the working power of the furnace is directly proportional to the outlet temperature of the furnace. That is, when the oven power is high, the flue gas temperature is also high. Therefore, the flue

gas temperature directly refers to the boiler inlet temperature, that is, the temperature of the gas heating the water. The higher this temperature, the better the evaporation will be. It is easier to evaporate the water with high temperature because the feed water is heated by preheating the water in the tank. This means that the steam that needs to be created is easier to build. Because the heat required to evaporate cold water is higher than the heat that must be supplied to heat the hot water. The higher the amount of steam produced, the higher the amount of electricity produced. The number of active stages of the turbine will increase and the force generated will increase in direct proportion to the amount of steam. The ID-Fan devride affects steam production. If the ID-Fan cycle is not adjusted according to the flow of the flue gas, the steam production amount will decrease. If the gas flow is low, and the ID-Fan cycle is not at the proper value and the gas passes quickly through the boiler, the flue gas heat will leave the boiler without passing the water heat through the pipes, which will reduce the amount of steam. It also affects the amount of steam production and the amount of electricity generated at the outside temperature. When the outdoor temperature is low, the temperature of the flue gas in the flue gas channels will decrease. This will cause the boiler inlet gas temperature to decrease. In addition, when the ambient temperature is low on the steam transmission lines, the transmission will be condensed at the surface of the line, and the steam temperature and steam amount will decrease accordingly.

Even if the transmission lines are not drained, the turbine will be dismantled. On the other hand, when there is a malfunction in the steam turbine or generator, the superheated steam auxiliary condenser is transferred to the hot steam generator system so that it does not stop. It does not lose the hot steam feature on this. That is to say, electricity is produced as a result of the closed cycle with the steam produced depending on these variables. In addition to all these, dust and harmful residues in the gas taken from the flue are trapped by the filter bags. The dust and harmful debris carried by the conveyor system to the powder silos are removed by passing through the chemical process. At this point, the facility becomes an environmentally friendly facility at the same time. Also in the cogeneration plant belonging to Eti Krom A.Ş., since there are two furnaces, there are two boilers. For this reason, the amount of steam generated from the boiler, which is the same, is twice as much.

There are many studies about electricity production [1-8]. However, Elazığ Etikrom A.Ş. does not have any studies that classified by artificial neural network according to the values affecting electricity generation. The purpose of this article is to classification by artificial neural network according to the values affecting electricity generation of the Etikrom A.Ş. The novelty of this study, when studies in the literature are examined, it is seen that k-means and Artificial neural network are not used in together to classification Oven Power (MW), Boiler Inlet Gas Temperature, Amount of Steaming Steam, ID-Fan Speed, and Feeding Water Tank Datas taken from Etikrom A.Ş. Also, Analysis Oven Power (MW), Boiler Inlet Gas Temperature, Amount of Steaming Steam, ID-Fan Speed, and

Feeding Water Tank Datas taken from Etikrom A.Ş have been done with ROC curve.

Theory and Method of the study are described in Section 2. Experiment results and conclusions are explained in Section 3 and Section 4, respectively.

Theory and Method

Obtaining the data

Electricity generation datas in this article have been taken from Etikrom A.Ş. The electricity generation datas are valid for the first four months of 2017. It consists of total and instant values for each hour. It consists of total and instant values for each hour. The k-means clustering method is defined as low electricity level between 0-2.33 MW, medium electricity level between 2.333-2.39 MW, and high electricity level between 2.391-3.39 MW.

In this article, the proposed system for classification by artificial neural network according to the values affecting electricity generation taken from Elazığ Etikrom A.Ş. is shown in figure 1.

In this article, according to the figure 2, Etikrom A.Ş. den Furnace Power, Boiler Inlet Gas Temperature, Superheated Steam Amount, ID-Fan Speed Speed, Feeding Water Tank, Electricity production values were taken.

Later, only electricity generation values were clustered by the k-means method. The values of kiln power, boiler inlet gas temperature, superheated steam, ID-Fan speed, feeding water tank values which are used to generate electricity by using cluster data as verification data are used as a classification feature. Artificial Neural Network was used as a classifier. Then, the classification of ROC curve was analyzed.

K-means clustering algorithm

The k-means algorithm uses it intuitively to find the center seeds for the k-median clusters. According to Arthur

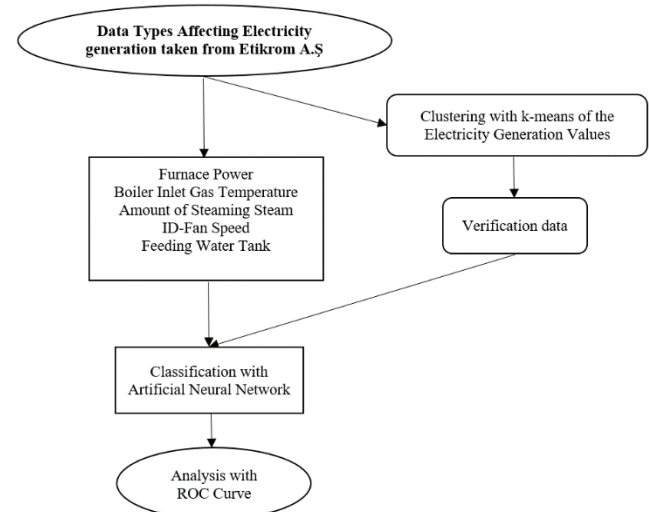


Figure 1: Suggested System.

and Vassilvitskii [9,10], k-means improves the working time of the Lloyd algorithm and the quality of the final solution [9-13]. The k-means ++ algorithm chooses the seeds as follows, assuming that the number of clusters is k.

Step 1: Select a random observation of Z from the data a_1 set. The selected observation is the first center, designated as $d(z_b, a_f)$

Step 2: Calculate a_1 distances from each observation. Let be the distance between and observation b.

Step 3: Select the next centroid, a_2 at random from Z with probability.

$$\frac{d^2(z_{be}, a_1)}{\sum_{f=1}^n d^2(z_f, a_1)}$$

Step 4: To choose center f: Calculate the distance of each observation to each center and assign each observation to the nearest center. For $b = 1, \dots, n$ and $p = 1, \dots, f - 1$, select centroid p at random from Z with probability

$$\frac{d^2(z_b, a_p)}{\sum_{\{l: z_l \in a_p\}} d^2(z_l, a_p)}$$

Where A_p is the set of all observations closest to centroid a_p and a_b belongs to A_p .

That is, a probabilistic distance from each center must be selected that is proportional to the distance to the nearest selected center.

Step 5: Repeat step 4 until K centroids are selected. Using a simulation study of several cluster orientations, Arthur and Vassilvitskii [9,10] show that k-tools provide a faster convergence of cluster-centric distances from square points to the sum of a cluster set lower than Lloyd's. algorithm [9-13]."

Experimental Results and Discussion

Electricity production amount to be produced in Elazığ Etikrom A.Ş. was estimated by using Furnace Power (MW) obtained from Etikrom A.Ş., Boiler Input Gas Temperature, Superheated Steam Quantity, ID-Fan Speed Rate, Feeding.

Water Tank data. Electricity generation amount is used as verification data. That is, by the k-means clustering method, the electricity generation amount is divided into 3 classes (low, medium, and high). 3621 data including Furnace Power (MW), Boiler Input Gas Temperature, Superheated Steam Amount, ID-Fan Speed, and Feeding Water Tank data were used after class 3 separation. With the k-means clustering method, 2742 of these data were clustered as low electricity, 296 as medium electricity and 583 as high electricity. This clustered data was given to the Artificial Neural Network classifier. The success rate obtained as a result of this classification is 85.81%. Classified data were analyzed by ROC curve.

In table 1 is seen examples of data affecting electricity generation. This values is determined as low-level classification with k-means method.

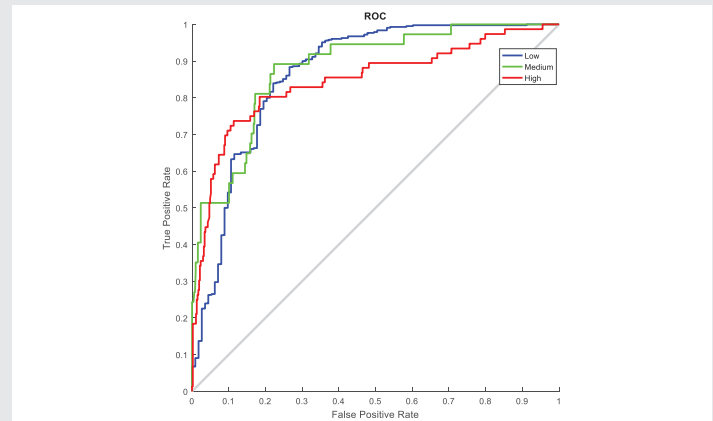


Figure 2: Display of data affecting electricity generation by ROC curve

Table 1: Examples of data affecting electricity generation taken from elazığ etikrom a.ş.

Furnace Power	Boiler Inlet Gas Temperature	Amount of Steaming Steam	ID-Fan Speed	Feeding Water Tank
21	484	7,5	451	106
21,2	500	7,65	451	106
21,4	501	8,6	451	106
21,1	518	7,85	456	106
21,6	434	9,09	456	106
21,1	457	7,4	456	106
20,7	506	9,45	448	106
20,4	489	7,95	448	106
21,8	493	7	448	106
21,2	515	6,9	448	106
21,2	514	7,92	448	106

Conclusion

Predicting the amount of electricity produced in a power plant is very important for today's economy. To date, there are many field work for classification or clustering [14-28]. Electricity generation datas in this article have been taken from Etikrom A.Ş. The electricity generation datas are valid for the first four months of 2017. The k-means clustering method is defined as low electricity level between 0-2.33 MW, medium electricity level between 2.333-2.39 MW, and high electricity level between 2.391-3.39 MW. Furnace Power (MW), Boiler Input Gas Temperature, Superheated Steam Amount, ID-Fan Speed, Feeding Water Tank data affect the electricity production. In this article, Etikrom A.Ş. The electricity production amount to be produced in Elazığ Etikrom A.Ş. was estimated by using the data of Furnace Power (MW), Water Inlet Gas Temperature, Steam Vapor Volume, ID-Fan Speed, Feeding Water Tank data. Electricity generation amount is used as verification data. That is, by the k-means clustering method, the electricity generation amount is divided into 3 classes (low, medium, and high). 3621 data including Furnace Power (MW), Boiler Input Gas Temperature, Superheated Steam Amount, ID-Fan Speed, and Feeding Water Tank data were used after class 3 separation. With the k-means clustering method, 2742 of these data were clustered as low electricity, 296 as medium electricity and

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