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POWER CONSUMPTION ESTIMATION USING ARTIFICIAL NEURAL NETWORKS: THE CASE OF TURKEY

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Abstract:
A significant proportion of the world energy consumption is by developing countries. As a developing country, Turkey is one of the leading countries in terms of the increase in energy demand. According to the data from the Ministry of Energy and Natural Resources, Turkey is the country with the greatest increase in demand after China in electricity and natural gas consumption since 2000. In 1970, the ratio of total energy production to consumption in Turkey was 76%. In year 2000, this ratio dropped down to 35%, in year 2010 to 26% and predicted to come down to 23% by year 2020. This situation indicates an increase in Turkey's energy dependency every passing year and the need to implement solutions to reduce this dependency. Today, electric energy has become a very critical and indispensable part of the development of technology. Production and consumption of electrical energy, which facilitates human life and increases labour productivity, are increasing every year. Electricity is a versatile and easily controlled form of energy. Electricity is practically non-existent and non-polluting at the point of use. Electricity can be cleanly produced by completely renewable methods such as wind, water and sunlight at the production point. Electricity market has a unique feature compared to other commodities. This feature requires the consumption of electricity when it is produced. Forecasting the future consumption of electricity in Turkey is crucial in making strategic plans for the future and taking the necessary measures. In Turkey, the consumption of electricity in the estimation studies were generally observed that the use of long-term electricity consumption prediction method of neural networks. In some studies, the results obtained by artificial neural network method are compared with Box-Jenkins models and regression technique. As a result of comparison, artificial neural networks seem to be a good predictor of electricity consumption. In this study, electrical consumption is modelled by using artificial neural network method and the results are discussed. In the application, the four main factors that affect the electricity consumption in Turkey is considered as independent variables. These independent variables are; Population, Imports, Exports, Gross Domestic Product (GDP). How these independent variables affect the electricity consumption in the country was found as the result of the tests made and the results were evaluated.

Keywords:
Electric energy, prediction, future, artificial neural networks, electricity consumption estimation.

1. Introduction
Evaluation The energy sector is a particularly important sector for economically developing countries. It is also seen that the energy sector plays a very important role in the global economic context. Oil prices and other energy sources affect the economies of some developing countries and play an important role in shaping the economies of these countries. Turkey's dependency on energy imports is increasing due to the increasing energy demand. Currently Turkey, only 26% of total energy demand can be met from its own internal resources. Electric energy is a versatile and easily controlled form of energy. Electricity is practically lossless at the point of use and is not polluting. At the production point, it is a clean energy type that can be produced from completely renewable sources such as wind,

water and sun. Turkey Electricity Transmission Company in the last seven-year projections made by the company, the peak demand under the high demand assumption cannot be met in 2020. The necessity of consuming electricity is one of the characteristics of the market that is unique compared to other commodities. For this reason, the conditions of the electricity market are unique. Turkey, including the privatization and liberalization of the energy market, has launched a reform program. In 2001, the Electricity Market Law No. 4628 went into effect and created a regulatory framework to provide high quality to consumers with cost efficiency. Thus, estimating the demand for electricity becomes very important when balancing the market and at the same time achieving the equilibrium price.

Several methods have been used in literature to estimate electricity consumption, such as artificial neural networks and neural fuzzy logic. The literature also includes the work of Auto Regressive Integrated Moving Average and Error Correction Models (ECM), smoothing methods, decomposition and hybrid approach methods, and decomposition and time series models. This study aims to model electricity consumption by using artificial neural network method. Due to economic fluctuations in the world and in Turkey, electricity consumption has a chaotic and non-linear trend. For this reason, estimating studies on net electricity consumption have a vital prospect in determining the energy policy, especially for countries where energy demand is rising rapidly.

(Sözen, Arcaklioğlu, & Özkaymak , 2005), an Artificial Neural Network model to predict the energy consumption in Turkey has carried out work. (Akay & Atak, 2007) using a gray forecasting method with a rolling mechanism to estimate the consumption of electrical energy. (Kavaklioglu, Ceylan, Ozturk, & Canyurt, 2009) proposed an Artificial Neural Network model for forecasting net energy model in Turkey. Variables used in the estimation of electricity consumption for the period 1975-2006; population, gross national product (GNP), import and export. (Kavaklıoğlu, 2011) Support Vector Regression (SVR) has estimated the consumption of electricity in Turkey with the methodology. (Çunkaş & Taşkiran, 2011) Genetic Algorithms method with an estimated electricity consumption in Turkey. (Hamzaçebi & Es, 2014) optimize our recurring covering the years 2013-2025 to estimate the total electricity demand in Turkey has developed a gray modeling. (Kaytez, Taplamacioglu, Cam, & Hardalac, 2015) least squares support vector machine for Turkey's energy consumption (LS-svms) offered.

2. Energy Policies in the World and in Turkey

Energy is a significant concept for development and an essential input to production. It is almost impossible to produce without energy resources. Energy resources are required also for the transportation of the produced goods. Energy resources are the direct input to production of certain goods. For others, they can be side inputs, such as heating, decomposition or electricity needs. As an example, the primary materials for vehicle tyres are petroleum products. But for iron production, its heating properties are used (Wilcock, Pallemaerts, & Kummer, 1993). A significant proportion of the world energy consumption is by developing countries. As a developing country, Turkey is one of the leading countries in terms of the increase in energy demand. According to the Ministry of Energy and Natural Resources (MENR), increase in the primary energy demand in Turkey between years 1990 and 2008 is 4.3%, which is 3 times the world average. On the other hand, since year 2000, Turkey is the country with the highest demand increase in electricity and natural gas consumption after China. In 1970, the ratio of total energy production to consumption in Turkey was 76%. In year 2000, this ratio dropped down to 35%, in year 2010 to 26% and predicted to come down to 23% by year 2020 (www.enerji.gov.tr, 2018). This situation indicates an increase in Turkey's energy dependency every passing year and the need to implement solutions to reduce this dependency. On the other hand, the share of fossil fuels in the total energy consumption is growing. The main reason for this is the use of fossil fuels instead of renewable energy resources to meet the growing energy demand.

According to the study conducted by the Ministry of Forestry and Water Management, the share of hydroelectric power plants in the overall energy production rose to 25%. The share of total renewable energy resources is around 30%. In Turkey's Energy Outlook Report published by MENR, the following targets were identified for renewable energy for 2023:

- to increase the power installed over wind energy to 20.000 MW (as stated in the Energy Market and Security of Supply Strategy Document), 3.000 MW in solar energy and 600 MW in geothermal energy are targeted.
- • it is aimed to increase the share of renewable resources in electricity production to 30% by 2023 and to reduce the share of natural gas to 30%.

- • hydroelectric power plants with a total installed capacity of 20.000 MW are targeted to be built by the private sector.

In the 2030 targets study of Energy Market Regulatory Authority (EMRA), utilization of renewable energy resources is targeted and a growth scenario is also provided. In this scenario, the growth in the use of hydroelectric and wind energy specifically, whose high potential is extremely under-utilised, is remarkable. Increase in the share of solar energy utilisation, which has almost no utilisation at present, will also be a significant improvement. The "Regulation on Unlicensed Electricity Generation in Electricity Market" no. 28001 enacted on July 21, 2011 and the "Notice on the Implementation of the Regulation on Unlicensed Electricity Generation in the Electricity Market" no. 28229 dated March 10, 2012, enabled electricity production up to a certain capacity, without requiring a license application. This way, it becomes possible for households and factories to generate their own electricity from renewable resources.

2.1. Determination of Energy Demand in Turkey

After 1980 resolutions, energy demand and consumption increased rapidly, due to rapid population growth and industrialisation. The impacts of the 2008 crisis were observed in Turkey in 2009, and there has been a decline in the energy consumption, along with a contraction in the industrial sector. As of 2011, Turkey meets approximately 83% of its energy consumption need through imports. The share of these imports on current deficit is around seventy per cent (Yanar & Kerimoğlu, 2011). Besides having a significant share of 54 billion dollars in the current deficit, due to the high cost of this amount, technology imports cannot be realised at an adequate level. Although energy consumption is most influential in the industrial sector, it is also important for the agriculture and services sectors. As almost all of the energy input used in agriculture in Turkey is imported, costs are rising. Many agricultural goods can no longer be produced for this reason, so they are imported. As of 2014, Turkey holds only 1% of the world's primary energy consumption (BP Statistical Review of World Energy, 2015).

Both the real GDP and the primary energy consumption of Turkey have increased over years. The decline in GDP in year 2009, as in many economic indicators, is due the impacts of the 2008 crisis being felt in Turkey in 2009. Furthermore, throughout the period of crisis, primary energy consumption followed a steady course. Turkey's having the lowest primary energy consumption among the MIST countries is conspicuous.

2.2 Electricity Consumption in Turkey

Power consumption in Turkey is increasing everyday, by virtue of technological improvements and advantages of keeping pace with the modern times. But there are still major issues with electricity production. In this respect, it is essential to estimate the electricity requirement and to draw a roadmap accordingly. Following table illustrates the power consumption rates in Turkey, in linear graphics:

Figure 1. Total Monthly Electricity Consumption (GWh)
Source: http://enerjienstitusu.de/elektrik-tuketim-istatistikleri/, Access Date: 01.05.2018

According to the above graph, power consumption ratios show a linear growth between years 2010 and 2017. Every year, more electricity was consumed than in the previous year, and consumption rates differed according to months. Electricity consumption rates were at the highest levels specifically in August and December, while they remained lowest in February and April.

Table 1. Total installed capacity, gross production, and net electricity consumption of power plants

Year	**Total installed capacity** (MW)	**Gross Production** (GWh)	**Net Consumption** (GWh)	**Year**	**Total installed capacity** (MW)	**Gross Production** (GWh)	**Net Consumption** (GWh)
1975	4 186,6	15 622,8	13 491,7	**1996**	21 249,4	94 861,7	74 156,6
1976	4 364,2	18 282,8	16 078,9	**1997**	21 891,9	103 295,8	81 885,0
1977	4 727,2	20 564,6	17 968,8	**1998**	23 354,0	111 022,4	87 704,6
1978	4 868,7	21 726,1	18 933,8	**1999**	26 119,3	116 439,9	91 201,9
1979	5 118,7	22 521,9	19 633,1	**2000**	27 264,1	124 921,6	98 295,7
1980	5 118,7	23 275,4	20 398,2	**2001**	28 332,4	122 724,7	97 070,0
1981	5 537,6	24 672,8	22 030,0	**2002**	31 845,8	129 399,5	102 948,0
1982	6 638,6	26 551,5	23 586,8	**2003**	35 587,0	140 580,5	111 766,0
1983	6 935,1	27 346,8	24 465,1	**2004**	36 824,0	150 698,3	121 141,9
1984	8 461,6	30 613,5	27 635,2	**2005**	38 843,5	161 956,2	130 262,9
1985	9 121,6	34 218,9	29 708,6	**2006**	40 564,8	176 299,8	143 070,5
1986	10 115,2	39 694,8	32 209,7	**2007**	40 835,7	191 558,1	155 135,2
1987	12 495,1	44 352,9	36 697,3	**2008**	41 817,2	198 418,0	161 947,6
1988	14 520,6	48 048,8	39 721,5	**2009**	44 761,2	194 812,9	156 894,1
1989	15 808,2	52 043,2	43 120,0	**2010**	49 524,1	211 207,7	172 050,6
1990	16 317,6	57 543,0	46 820,0	**2011**	52 911,1	229 395,1	186 099,6

1991	17 209,1	60 246,3	49 282,9	**2012**	57 059,4	239 496,8	194 923,4
1992	18 716,1	67 342,2	53 984,7	**2013**	64 007,5	240 154,0	198 045,2
1993	20 337,6	73 807,5	59 237,0	**2014**	69 519,8	251 962,8	207 375,1
1994	20 859,8	78 321,7	61 400,9	**2015**	73 146,7	261 783,3	217 312,3
1995	20 954,3	86 247,4	67 393,9	**2016**	78 497,4	274 407,7	231 203,7

Source: http://www.tuik.gov.tr/PreTablo.do?alt_id=1029, Access Date: 17.03.2018

A dramatic increase in electricity consumption is observed from year 1975 through 2016, according to the above table. Electricity consumption has increased every year without exception. Electricity production has grown day by day in connection to electricity consumption. This continuous and rapid increase in electricity consumption has made the estimation of power consumption an even more significant area. In this respect, deepening the studies on this subject, and making an accurate and clear estimation of electricity consumption is very important.

3. Artificial Neural Networks

Learning, adopting, association and generalisation abilities of the human brain are superior to the capabilities of any computer. This ability led researchers to work on modelling the human brain in simplified form (Karna & Breen, 1989). Artificial neural networks, which were created through these models, provided positive contributions in finding solutions to various tabulation problems.

Artificial neural networks' estimation quality was found to be significantly better than regression methods'. The question at the focus of ANN studies is, how the loads should change the signals. At this point, what kind of output will be generated by the data input in any form, varies by different models. Another important difference is the way in which data are stored in the system. In neural design, the data stored in the computer is represented by a complete phase made up of the collection of the small load units distributed throughout the system. When new data are transferred to the medium, instead of a bulky local change, a small change is made on the whole system. Today, neural network applications are implemented either by using software simulators on traditional computers or by using computers with special hardware. Applications for various purposes, from credit risk assessment to signature verification, from account estimation to production quality control are implemented by using software packages (Samarasinghe, 2016).

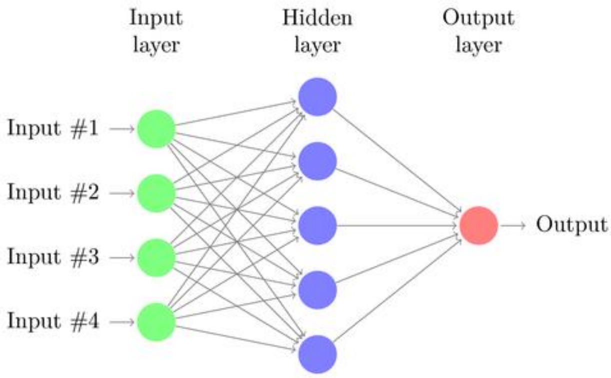
3.1 Estimation of Electricity Consumption by Artificial Neural Networks

While there are many types of artificial neural networks, use of some are more common than the others. The most commonly used artificial neural network is the one known as the back-propagation artificial neural network. This type of artificial neural network provides good results in estimation and classification operations. Another type is the Kohonen Self Organising Map. These types of neural networks provide successful results in finding the relationships between mixed data sets. ANN is successfully used in processing indefinite, noisy and incomplete data. ANN methodology, which should be seen as a technological advancement, provides significant advantages by virtue of its features and capabilities. It can be stated that ANN draws its computing and data processing capability from its parallel-distributed structure, learning and generalisation capability. Generalisation is defined as, generation of appropriate responses by ANN, also for the entries that are not introduced in the training or the learning phase. These superior features demonstrate ANN's ability to solve complex problems (Lek & Guegan, 1999).

The forward estimation of electricity consumption in Turkey is essential for strategic planning and taking the necessary measures for the future. For this aim, overall power consumption estimation is performed by using the artificial neural networks method, for the whole country.

4. Data and Method

ANN can be represented in broad terms with the following scheme. Here, input values and the number of neurons are figurative. These values can be determined specifically for each study.



In this section, implementation steps for ANN's "electricity consumption estimation in Turkey" problem are described and the factors for consumption demand are analysed. The performance of ANN and how well the ANN model learns the data are analysed. The most commonly used accuracy models are (Gately, 1996):

- Mean Absolute Error (MAE, MAD) =∑|et|/N,
- Sum Squared Error (SSE) =∑(et)2,
- Mean Squared Error (MSE) = ∑(et)2/N,
- Root Mean Square Error (RMSE) ,
- Mean Absolute Percentage Error (MAPE) =(1/N)∑|et/yt |(100)

  et, estimation error,
  yt, t term observation value,
  N, number of error terms

The most commonly used criterion among these is MSE. An important feature of this criterion is the capability of parsing the estimation error into variance sums. MSE criterion will be used to measure the performance of our study.

4.1 Definition of the Problem

Net electricity consumption data for Turkey between years 1975 and 2016 are available and the electricity consumption in Turkey between years 2017 and 2030 will be estimated by using the ANN method. Presence of factors that may influence electricity consumption is natural. Following are the four factors we will use as input in our study and the electricity consumption data, in addition to these four factors:

1. Population: Number of people living in a region with definite borders is called population. An increase or decrease in the population of the region is expected to affect the electricity consumption in that region.
2. Import: It is the purchase of goods produced abroad by the buyers in the country. It is one of the main factors determining the foreign trade balance of the country. An increase or decrease in the importation volume in the region is expected to affect the electricity consumption in that region.
3. Export: It is the process of selling a product produced in the country, to a foreign country with foreign exchange. It is the other one of the main factors determining the foreign trade balance of the country. An increase or decrease in the exportation volume in the region is expected to affect the electricity consumption in that region.
4. Gross Domestic Product (GDP): It describes the market value of the final goods and services produced in the country within a certain period (usually 1 year) in terms of the monetary value unit. As it increases the purchasing and production power of the people, an increase in GDP value is expected to increase electric energy consumption.
5. Net Electricity Consumption (GWh): The abovementioned population, importation, exportation and GDP parameters are expected to affect power consumption.

4.1.1 Artificial Neural Network Architecture

In determination of the parameters to be used for implementing the most suitable ANN structure, there are some techniques to be used, although not very clear. However, these methods are complex and difficult to implement. It is not certain either that they will provide the most appropriate solutions for the real estimation problems. Because of this feature, ANN design is often referred to as an art, rather than a science (Zhang, Patuwo, & Hu, 1998) (42,44,49,50)

4.1.2 Network Training

"Network training" is performed during the determination of the neuron connection weight values of the ANN. Initial values are random. Weight values are changed as examples are shown to the ANN (Öztemel, 2006). In the literature, number of data, training and test data set distribution is observed to be distinguished in the ratios of 90% - 10%, 80% - 20% or 70% - 30%. According to this rule, while the training data set is used to develop the ANN model, test data set is used to develop the estimation capability of the model. Errors in selection of the training and test data set affect the network performance. Data representing the sample space should be used for this reason (Zhang, Patuwo, & Hu, 1998).

It is observed that the back propagation algorithm is widely used in the studies regarding consumption estimations, so the multilayer, feed-forward, back-propagation algorithm is used in this study. Among the data of the 42 terms between years 1975 and 2016, 70% are used for network training, 15% are used for network verification and 15% are used for testing the network. Figure 2 illustrates the implemented artificial neural network model.

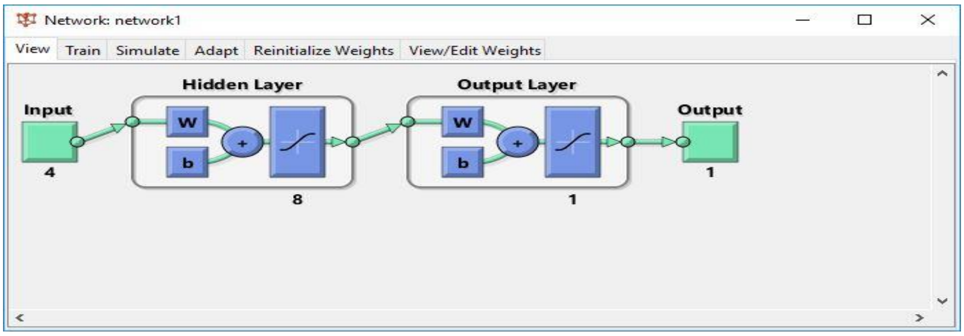


Figure 2. Artificial Neural Network Illustration

As seen from the network scheme, 4 inputs with 8 neurons are used and 1 output is obtained.

4.1.3 Normalisation of the Data

"Data normalisation" operation used during the learning process of ANN is studied, and it is concluded that normalisation is useful, but the advantage is reduced as sample size increases. With the normalise operation; extreme values are eliminated so that data can be modelled more efficiently. Selection of the normalisation interval depends on the transfer function of the neurons in the output layer. If Sigmoid function is used in the output layer, normalisation interval is selected as [0,1], if hyperbolic tangent function is used, normalisation interval is selected as [-1,1] (Zhang, Patuwo, & Hu, 1998). Since our study uses Sigmoid function, normalisation method is transformed to transfer within [0 - 1] interval.

4.1.4 Hidden Layer and Determination of the Number of Neurons

Number of hidden layers varies according to the research area, data size and design. Usually, one or two hidden layers are sufficient. Increasing the number of hidden layers reduces network speed and may cause the network to memorise; whereas our aim is to enable the network to learn. A three-layer structure as input-hidden-output is generally preferred. If the results are not sufficiently satisfactory, 2 or 3 intermediate layers can be experimented. It is observed that in solution of many estimation problems, there is no need for more than 2 hidden-layer structures (Zhang, Patuwo, & Hu, 1998). Moreover, implementations reveal that, more than a total of 4 layers has reverse effect on successful performance (Kaastra & Body, 1996). Although there is no definite rule in determining the number of neurons in the hidden layer, the optimum value depends on the network structure, amount of data, type of problem and the experience of the designer. Number of neurons in the hidden layer is generally determined by trial and error. In our study, we determine the neuron count by using the trial and error method. Our model consists of the input layer, hidden layer and output layer. In the input layer there are 4 cells and in the output layer there is 1 cell (knot). Tests are run to determine the optimal number of neurons in the hidden layer. Survey of research conducted on ANN, concludes that 1 or maximum two hidden layers are preferred. Single hidden layer is used in our study.

4.1.5 Artificial Neural Network Matlab Implementations

Matlab implementation is performed with the acceptances described in Table 2.

Table 2. Matlab Programming Language – Accepted parameters regarding the ANN method

Network Type	Feed-forward backprop
Training Function	Traingdx
Adaption learning function	Learngdm
Activation Function (Transfer function)	Tansig – Tangent Sigmoid Function
Performance	MSE – Mean Square Errors

The number of cycles and the number of circuits are kept constant and learning coefficient, momentum factor and number of neurons are tested to determine the optimal values. Constant values used for the Matlab implementation are listed in Table 3. It's observed that changes in the learning coefficient, momentum factor and the number of neurons affect the results and many trials were run to come to a conclusion.

Table 3. Accepted values of parameters to be used in ANN method

Cycle Quotient	1000
Circuit Count	1000
Number of Hidden Layers	1
Number of Layers	3

4.1.6 Determination of the Learning Coefficient

"Learning Coefficient" is tested with 8 neurons, momentum factor 0,9, by assigning numbers within [0,01 – 0,09] interval. As the result of the tests, the learning coefficient giving the minimum MSE value is found to be 0,01.

4.1.7 Determination of the Number of Neurons and the Momentum Factor

Momentum factor is the addition of a certain ratio of the change in the previous iteration, to the new change value. It is a factor effective on learning performance. When this value is low, it gets more difficult to eliminate regional solutions, whereas a large value may cause problems in reaching a single solution (Yücesoy, 2011).

It is known that the smaller the number of neurons in one layer, the higher the generalisation capability of ANN. Excessive number of neurons may cause the network to memorise the data, which is not a desirable situation. More than a hundred trials are run to determine the number of neurons and the momentum factor; the learning coefficient 0,01, obtained in the previous experiment is used as a constant, the number of neurons are kept within the [2-10] interval respectively, and values within [0.1-0.9] interval are assigned to the momentum factor respectively. As the result of these experiments, the minimum MSE value of 0,000130 was obtained at 8 neurons and momentum factor 0,9.

4.2 Testing and Evaluation of the Results

After the test process, the estimate test output data obtained from the network are compared with the actual values. According to this comparison, MSE value is obtained as 0,0024. ANN parameters specified in Tables 4.4 and 4.5 are used with 0,0024 error margin. This error margin is accepted to be sufficiently low, so electricity consumption for years 2017 to 2030 will be estimated by using these same parameters.

Table 4. Comparison of the estimate values by ANN and the actual values

Year	Actual value (normalise)	Estimate value (normalise)	Actual value	Estimate value
2002	0,410892019	0,413996862	102.948	103.624
2003	0,451395125	0,447768088	111.766	110.976
2004	0,494461253	0,482724168	121.142	118.587
2005	0,536356108	0,518353689	130.263	126.344
2006	0,595186203	0,569085398	143.071	137.389
2007	0,650598934	0,661000563	155.135	157.400
2008	0,681892613	0,726277714	161.948	171.611
2009	0,658678427	0,75382554	156.894	177.609

2010	0,72829802	0,753509078	172.051	177.540
2011	0,792828314	0,83105055	186.100	194.421
2012	0,833354386	0,849768432	194.923	198.497
2013	0,847694451	0,862369319	198.045	201.240
2014	0,890549291	0,869397325	207.375	202.770
2015	0,936192221	0,902064276	217.312	209.882
2016	1	0,95850592	231.204	222.170

Table 4 below displays the sum of the estimate and the actual values. There is an error margin of 0,0024 between the test data and the estimate values. Figure 4.12 illustrates the comparison of the real values and the output estimate values.

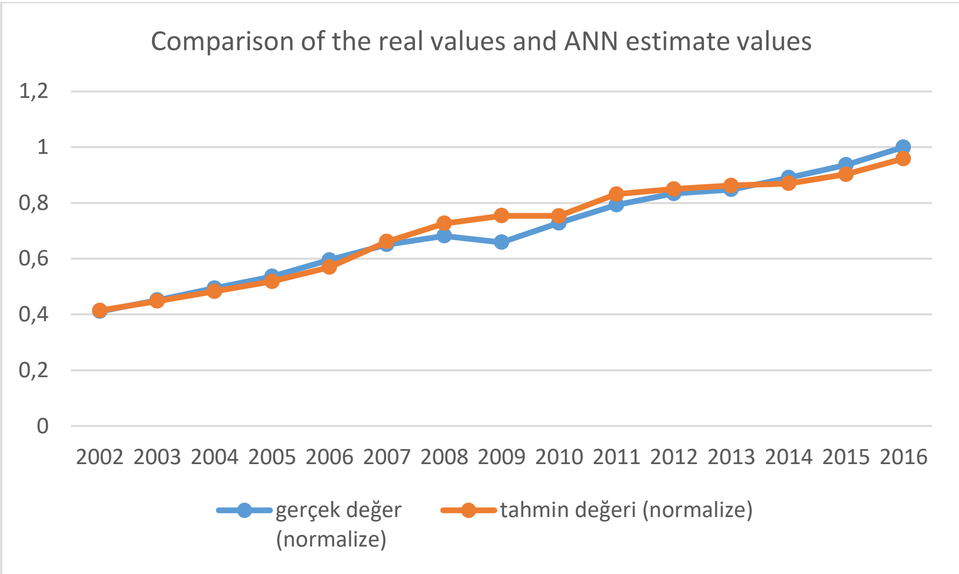


Figure 3. Graphics representation of the estimate values by ANN and the real values

Figure 3 contains a graphical representation of the 15 pieces of data we selected for the test set and the estimate values generated by the ANN network. As it can be seen on the graph, actual values are well estimated.

4.3 Consumption Estimation Implementation with ANN

It can be seen that, our network, trained with 205 pieces of data we had, is tested with 75 pieces of data along with the specified parameters, performs ideally with an error margin of 0,0024. Under these assumptions, the network will be tested to estimate electricity consumption for years 2017 – 2030. Our estimate data regarding this period are given in Table 4.7. Among these values, Population values are obtained from TÜİK (Turkish Statistical Institute) projections, GDP values are obtained from the data calculated by using the expected annual change percentages of the Ministry of Treasury, and import/export data is generated by the time series method of the matlab application. Table 5 shows the normalised test output values generated by the network as an estimate after the test process, as converted to actual value.

Table 5. 'Estimated electricity consumption' values converted from normalised estimate to real values

Year	Electricity consumption estimation (GWh)	Year	Electricity consumption estimation (GWh)
2017	296.018	2024	376.443
2018	302.304	2025	386.557
2019	292.293	2026	363.355
2020	325.232	2027	384.993
2021	341.088	2028	396.672
2022	346.650	2029	422.833
2023	323.958	2030	431.077

5. Conclusion

Estimation is forecasting how something will turn out in a future time, from today. Business decisions are made upon estimates for the future. Businesses need to take measures and make plans, determine their strategies today, by estimating now, the indefinite situations they may face in the future. In the studies we carried out for the solution of the problem, we tested the back-propagation algorithm of artificial neural networks as an estimation tool. ANN theory and the applications to be estimated are studied. In our application study, electricity consumption between years 1975 and 2016 is given in GWh. Factors affecting electricity consumption were specified by consulting experts in the interviews held before the study. Information on these factors was obtained from institutional sources such as TÜİK, TEİAŞ, MENR, the Ministry of Treasure, etc. In estimation of electricity consumption, the yearly net electricity consumption data in Turkey were taken into consideration. 4 main factors affecting electricity consumption in Turkey were addressed. These factors are; Population, Imports, Exports, Gross National Product. The extent to which these independent variables affect electricity consumption in the country were discovered by the tests performed, and the obtained results were evaluated.

Regarding these 4 factors, 168 pieces of data from 42 terms between years 1975 and 2016 were presented as "input", and 42 pieces of data regarding electricity consumption were normalised as "estimate" within [0 - 1] interval and presented to the network for training and testing purposes. Thus, the training of the network was performed and the optimum parameters to be used for testing were determined. The data on the last 15 years were re-entered into the network by using these parameters, the output estimate values were compared with the actual values, to calculate the MSE value. As the error margin 6,17E+07 turned out to be fairly acceptable, electricity consumption estimation between years 2017 and 2030, which is the main objective of this study, was performed with the same parameters, 6,17E+07 error margin, to obtain the target estimations.

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