Multivariate prediction of electricity consumption in Iran 2025 after statement with great countries of UN Security Council

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Abstract- Today among the various energies conspicuous, electric power is a significant source of industrial energy that is important for industries, agriculture and household use. Therefore, this article aims to study the trend of probable power generation in Iran, its state of consumption following Iran's vision plan in the year 2025. Although, there are some studies on Iran's electricity demands; the researchers studied on the relation between electricity consumption and GDP in a bi-variable assumption. Thus, this study focused on a multi-variable model to predict efficiently the electricity need for Iran 2025. During the recent years following sanctions, development of electricity power industry in Iran has been faced to some problems. Therefore, if the capacity of power plants in Iran would not be increased, it is anticipated that the relative probable power outages control would be unavoidable in the country, especially during peak hours. Accordance with international agreements made between Iran and effective United Nations Security Council members, Iran's electricity industry is going to prepare a development plan for increasing the present capacity. The most significant methods of domestic power generation in Iran include combined cycle, steam, gas, hydroelectric and other renewable methods. The generation rate of these methods is considered a target variable for predicted processes. The article has used a methodology based on the electricity power generated in different methods annually as the variables to plan the use of multilayer neural network for anticipating the future power generation and the required investment. Also, trend of some important parameters affecting the rate of electricity demand were investigated i.e. GDP, Steel production, Urban population and oil production in Iran. The performed research study in this paper is focused on production trend and diverse power generation methods in the country during the various years up to 2025, and the analysis of this report is based on this classification.

Key words: Electricity generation, Iran, Neural network, Prediction, Security Council.

I. INTRODUCTION

Global power industry has become more significant due to urban life and auto industrial development. Nowadays, develop of equipment and machines that work with electricity increasingly need the suitable power supply to answer the requirements of people and also the industries. Anticipating the electricity need is an important issue thus there are lots of studies focused on this area [1-6]. Although, there are some studies on Iran's electricity demands [1, 2]; the researchers studied on the relation between electricity consumption and GDP in a bi-variable assumption. Thus, this study focused on a multi-variable model to predict efficiently the electricity need for Iran 2025. Iran, having the population of about 78 million and the area more than 1.6 million square kilometers is known as a developing country [7]. In accordance to International Energy Agency, this country supplies more than 90% of energy from fossil fuel; the main reason is the capacity of Iran's crude oil and natural gas production equal to 162 Mtoe and 134 Mtoe respectively as the world seventh and forth rank [8]. Since domestic power supply requirements in any country is one essential factor in sustainable development, prediction of required electricity in the coming years is indispensable. Accurate prediction is a significant issue in the supply and demand management since it cannot be saved and expected to be used immediately. That is why numerous studies have been performed on power supply and demand predictions.

Since accurate prediction of power consumption is specifically essential for countries' energy plans, during the previous decades new techniques have been used to predict the power consumption to anticipate the accurate requirements for the future. Artificial Neural network frequently were used as a suitable method to forecast the energy consumption. In a survey carried by Kaytez et al. [9] the LS-SVMs method based on regression analysis and Artificial Neural Networks (ANN) was used to predict the electricity consumption in Turkey. In the model the installed capacity and the population rate in Turkey from 1970 to 2009 were considered as the independent variables. Zhang and Wang [10] based on daily electricity consumption in China, assert that in view of high increasing of demand energy, normal regression model does not provide accurate energy consumption prediction. Therefore, they applied the Fuzzy Wave Neural Network (FWNN) to combine experts' knowledge with target properties to overcome the disadvantages of forecasting methods in power consumption anticipation. Saravanan et al. [11] used the ANN and linear regression analysis to specify annual consumption

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predictions during the years 2011 to 2020 in India. For this purpose, population and GDP were used as input variables and anticipated power consumption as output variables were generated. The authors concluded that ANN model is quite flexible and it can provide the optimal solution of future demand anticipation. Marwala and Twala [12] used the Auto Regressive Moving Average (ARMA) neural networks and fuzzy neural models for future consumption anticipation in South Africa. The input data were used from the past records collected monthly from January 1985 up to December 2011. The results revealed that fuzzy neural model is more capable than other used methods; also they concluded that the neural network is better than ARMA. Azadeh et al. [13] used the Artificial Neural Network (ANN) for prediction of annual electricity consumption in high energy consumption industries. In this survey, chemical substances, metal bases and non-metal mineral industries were defined as the high energy consuming industrial sectors. Azadeh et al. used the actual data of industrial energy consumption collected between the years 1979-2003 in Iran. The authors concluded that the normal regression model for prediction of energy consumption of high energy consuming industries is not precise and accurate because the energy consuming in these industries changes unpredictably. Although artificial neural networks are generally used for short term consumption anticipation, this article express that the ANNs can be used for long-term anticipation as well. Also, in another study performed by Azade et. al. [14] the artificial neural networks (ANNs) for modeling of demand prediction of electricity power in power supply sectors were applied for Iran's demand as well. They compared the results obtained from ANN and those obtained from the simulated based ANN model. The used data is related to Iran's national electricity demand from 1994 to 2005. Also, Ringwood and Bofelli [15] developed an artificial neural networks (ANNs) for modeling of demand prediction of electricity power in power supply sectors. The used data is related to Republic of Ireland's national electricity demand. The article is focused on three various time scales: annual (fifteen years ahead), weekly (coming three years) and hourly (up to the next twenty-four hours).

Since residential power consumption in most developed countries has increased remarkably during the past years and especially during the summer, studies on the relation of electricity demand and electrical consumers (especially air conditioner) are significantly important. That is why a survey was carried by Marvuglia and Messineo [16] using a model based on Artificial Neural Network (ANN) for short term prediction of family electricity consumption (an hour) performed in neighboring of suburban area of Palermo (Italy). Hassan et al. [17] aimed to evaluate various algorithms cumulative efficiency for forecasting demand market in Australian energy market (AEMO) and New York Independent Site (NYISO). The authors used the single neural network models in a group. The research is formed of a 100 heterogeneous Neural Network Model structure group to create random order parameters. The NN models output is combined with three various cumulative algorithms. Observations indicate that cumulative algorithm have better performance and higher accuracy in comparison with individual NN models.

In another research carried by Xiufeng and Jian [18] five layer Fuzzy Neural Network (FNN) were introduced. The aim was to optimize network structure, introduce new methods of knot and promote the algorithm skill. Also, to learn the network of real data, Chinese data from 1980 till 2006 were applied in the study. In review and comparison of the results using real data of power consumption in 2006 and predicted data using FNN authors concluded that the method used is a high performance method and also accurate to anticipate the results up to 96.7%. Jia-hai and Xing-ping [19] using an improved neural network (BP) presented an adaptive learning method for power consumption forecast in China. The GDP, electricity energy consumption growth and the growth rate of the secondary industry were considered as input variables and in subsequence the power consumption of future year was predicted as the output. Simulated model of BP neural network improved the flexibility of conventional method of BP neural network in the presented article.

During the recent years, power industry in Iran is not sufficiently developed to reply the countries' present and future needs due to extensive sanctions. However, Iran and great countries' statement in UN Security Council has furnished the ground for various industrial development including electricity power industries. The issue has provided mutual opportunities for Iran on one side and global investors on the other side; that is why this article attempts to envision the investment requirements in this sector for the next ten years, in line with Iran ending 2025 vision documentary using a neural network prediction model. Iran's government urge to reach the objectives set in 2025 vision documentary, thus in this research capacity of electricity production in year 2025 is anticipated. In our survey, a multilayer neural network was applied based on the significant parameters like GDP, urban population and urban population growth and also oil production (as the most significant foreign exchange earnings in Iran) steel production and its consumption (as an important factor that shows the rate of development) to distinguish the future electricity consumption in Iran 2025.

II. Methodology

Artificial Neural Network (ANN)

In order to predict the required investment for 2025 in Iran electricity industry the Artificial Neural Network (ANN) is utilized in this investigation. In fact, there is a network which conceives node as artificial neuron and these types of neurons are known as Artificial Neural Network (ANN). In other words, an artificial neuron is computational model simulated from real human neurons. When modeling nerves, their complexities are disregarded and only the basic concepts are valued because other modeling approaches are arduous to be used. In a simple glance, nerve modeling must include inputs which act as synapses. These inputs are multiplied by weights to determine signal strength. Eventually a mathematical operator determines the certainty of activeness; in case of positivity the output is specified. Hence, an Artificial Neural Network (ANN) processes information by using a simplified model of real nerve. In view of aforesaid, a recommended simple model for defining a neuron can be 'node in the Artificial Neural Network (ANN)'. The model is presented in Fig. 1. Undoubtedly increase in the number of nodes makes the models difficult to be solved; therefore, new

methods are exigent to solve these issues. Here, the process of determining optimal of weighting and their value adjusts is mainly recursive. For this purpose, the rules and the known data are applied to educate the network thus network competence is acquired and miscellaneous algorithms are need to be proposed. All striving mentioned in this approach is used to make a network to anticipate the ideal output.

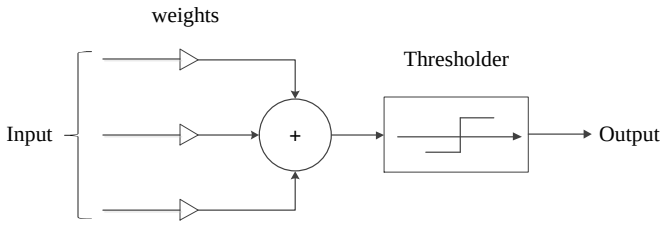

FIG. 1 – AN ARTIFICIAL NEURON SCHEME

MULTI-LAYER PERCEPTRON (MLP)

In order to use the ANN, in this research a Multi-Layer Perceptron (MLP) was applied as followed. In fact, one simple and at the same time effective proposed arrangements to be utilized in modeling of real nerve is Multi-Layer Perceptron (MLP). These arrangements are made up of an input layer, one or more hidden layers and an output layer. In this structure all neurons in one layer are connected to the neurons of subsequent layers. This arrangement is called a network with full connectivity comprises.

Fig. 3 manifests three layer perceptron network schemes. It can simply be concluded that the number of neurons of each layer is independent from the number of neurons in other layers. It should be noted that in Fig. 2 each aggregated circle represents aggregated operation and thresholding. In fact, each solid circle in this figure is a model of collector and block thresholding. It is shown in the below form as well to ease the display.

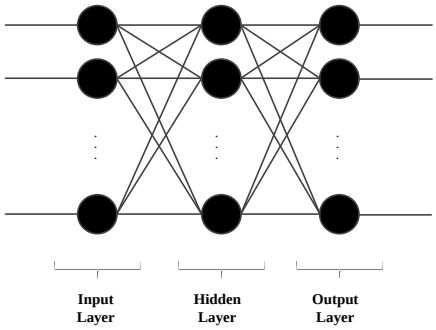

FIG. 2 - THREE-LAYER PERCEPTRON NETWORK SCHEME

Learning via Artificial Neural Network (ANN)

The main idea was propounded by Warren McCulloch and Walter Pitts [20] whom were simulated by the functions of neurons of human brain. The neural network is trained to solve the problems and in fact there are no preplans. Actually adjusting the weights of input of each neuron proportionally learn the network. The regulation is based on the model that shall incur with or without supervision.

In this article analysis of dependent variables are initially specified. For this reason, in addition to consider of total power generation during various years in Iran, different methods were studied separately. As a result, our target variables were selected as below:

1. Electricity generation by steam & Electricity generated by gas & Electricity generated by Combined Cycle (response 1)
2. Electricity produced by hydroelectric method & nuclear energy (response 2)
3. Total generation of electricity by other methods

The total power generation is higher than the existing set in form 1 & 2 because power generation in Iran can be applied in other methods.

For prediction of each of the above mentioned two types of independent variables are taken into account. The first group are related to variables of time-series variation for each target variables. This method for prediction of power generation is taken as work basis, based on previous two last years for anticipating the target year. Although, in view of the fact that Iran's total generation during nineteen years (1975-2014) is available, that seems good enough, the impact of other variables over each dependent variable was also

be studied. Due to this, a list of candidate variables for studying the rate of dependency to power generation in Iran were examined as mentioned below:

a) GDP per capita in Iran
b) Crude Oil Production in Iran
c) Urban population in Iran
d) Urban population growth in Iran
e) Steel Consumption in Iran
f) Steel Production in Iran

Bennouna and Hebil [21] discussed on close relation between GDP per capita and power consumption in Morocco. Also, Apergis and Tang [22] based on study on the statistical data from 85 countries showed that there is a close correlation between GDP and energy consumption in Iran and lots of other countries investigated in their study. Our data from Iran proves the relation between GDP and electricity generation in year 1995 up to 2014 as well. Figure 3 shows comparison between GDP per capita in Iran and the electricity generation. The R-squared i.e. coefficient of determination is about 94.8

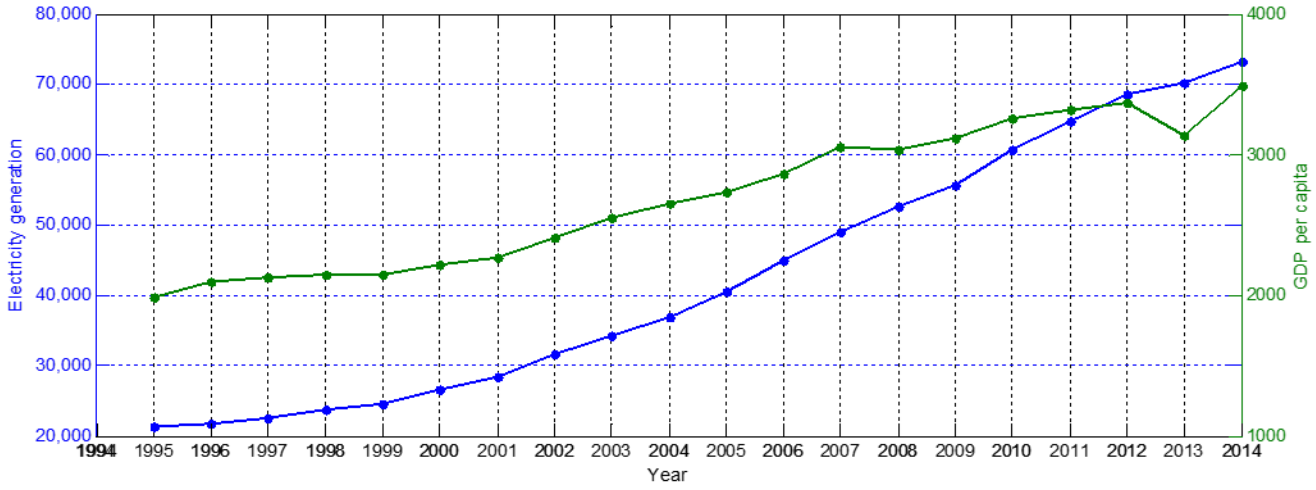

FIG. 3 – RELATIONSHIP BETWEEN ELECTRICITY GENERATION AND GDP PER CAPITA

One important parameter effects on Iran's income is the oil production rate yearly. Therefore, the correlation between oil production in the country and the electricity consumption was investigated as well. The result shows that there is a close relation between oil production and electricity consumption because r-squared is about 0.91. Also, the correlation between electricity consumption and four different parameters i.e. urban population, rate of urban population growth, steel consumption and steel production in Iran were studied as well. The results show that there are close relation between electricity consumption and the above parameters because the r-squared determined for these parameters are between 0.94 and 0.99

To evaluate the association of each variable over other response variables the rate of correlation is calculated. Based on this, in order to determine each variable as an input variable the neural network method is applied too.

The next stage, by utilizing the determined input, the neural network designed is learned to obtain regulated network parameters for future year predictions. Since the objective of this article is prediction of target variables in the horizons of 2025 the concerned network input shall be used for predictions in the same year. For this purpose, it is assumed that until 2025 war, earthquake and other force major events that may alter the overall pattern of results would not occur, so the overall pattern of data preserved is stable. On this basis, the nonlinear regression equation of each dependent and independent variable as inputs and outputs of the neural network can be obtained. These equations show the created transformations for each data during various years without observation of other variables impacts over them. Keeping the assumption of constant pattern data based is the advantage of these equations when they apply using the required input for power generation prediction up to 2025.

Table 1 exhibit the collected data of electricity generated by Ministry of Energy of Iran [23]. All data are arranged by electricity generation method in Iran during 1995 up to 2014 separately. Certainly, power generation can also occur using other methods such as atomic energy, wind power plant, solar power plant and combined cycle; the power generation with mentioned methods is totally shown in the last column.

TABLE1. THE RESULTS OF POWER GENERATION IN IRAN USING DEFERENT METHODS DURING 1995 TILL 2014 (MW)

Year	Method

	Response 1	Response 2	Other method	Total
1995	19303	1953	0	21256
1996	19789	1969	0	21758
1997	20581	1999	0	22580
1998	21822	1999	0	23821
1999	22632	1999	0	24631
2000	24656	1999	0	26655
2001	26401	1999	11	28411
2002	27987	3028	503	31518
2003	29399	4420	509	34328
2004	31771	5012	25	36808
2005	34459	6043	37	40539
2006	38251	6572	47	44870
2007	41510	7422	63	48995
2008	44791	7672	63	52526
2009	47961	7703	92	55756
2010	52213	8486	95	60794
2011	54944	9745	116	64805
2012	57577	10745	181	68503
2013	58395	11265	590	70250
2014	60736	11785	631	73152

Production Method Selection

Production method selection varies according to demand and regional conditions. Each power plant has its own advantages and disadvantages. Although rapid technological development makes the hope to reduce the costs of various power plants, some governments, which are the great oil and coal producers, prefer to use the coal, gas and oil for electricity power plant. However, energy production in industrial regions is more economical, and the largest world energy supply resources for electricity include: coal, natural gas, hydroelectric (hydropower), nuclear energy, oil and derivatives; other resources are placed in the same last row. Due to environmental pollution issues, power plants are usually established far from urban and residential areas. When there is high requirement and instant need for electrical energy the power cannot be supplied from some renewable energy such as sunlight and wind power. Further, the type of power used is also important to choose the type of power plant. As an example, gas source can easily be reduced or increased in load; also nuclear power plants can generate high scale of electrical energy easily; and hydropower is usually installed in areas where the ability of water movement from higher attitude to the lower level exists in capacity to drive the turbines. However, this type of power plant is not feasible in Iran because water storage capacity is limited in this country and during the year the consumption load is existed. Iran's capacity of producing the crude oil and gas is high and in fact its export them to other countries as the 8th producer in the world. Although the renewable energies protect the environment for future generations, the Iranian investors assume that the renewable energy resources such as hydro power, solar power, wind power, tidal etc. in view of present existing technologies are highly costly. Therefore, in a long term the investors in Iran have mostly preferred to produce the electricity via oil and gas resources.

Analysis of Effective Factors on Production Process

In this section, Iran's collected data in various fields effective on energy consumption are reviewed. The variables used in this study for predicting the future demand of electricity in Iran are as follows:

- GDP per capita
- Oil production (as the main source of Iran's income)
- Urban population (as the main electricity consumer)
- Urban population growth (as the stimulus of consumption)
- Steel consumption (as the factor of development)
- Steel production (as the main electricity consumer)

The reason of choosing above variables are discussing as follows. Apergis and Tang [22] concluded that GDP can effect on energy as an important factor; thus in this study trend of GDP was used in combine with some other important factors to predict the future power demand in Iran. Also, the main income of Iran's government is based on the oil export and this factor affect the infrastructure investment in the country. On the other hand, the urban population in Iran was increased in Iran from 36 to 56 million between 1995

and 2014 that rise the electricity consuming. In addition, one of the most electricity consuming industries in Iran is steel factories that affect the electricity demand. Finally, steel consuming from both sources of internal producing and imported one can affect the electricity demand. Thus these factors were chosen as the variable of this study. Table 2 reveals Iran annual statistics for each of these factors. As observed, the presented statistics indicate the increasing trend in general. Even if at times there were some falls in an area, once again it regained and returned to be increased.

TABLE 2 – ANNUAL STATISTICS OF EXTERNAL FACTORS

Year	GDP per capita (US $)	Crude Oil Production (MT)	Urban population	Urban population growth (%)	Steel Consumption (KT)	Steel Production (KT)
1995	1984.17	3643	36423717	2.772	5370	4696
1996	2091.42	3686	37532395	2.998	6764	5415
1997	2124.13	3664	38684432	3.023	7410	6322
1998	2142.23	3634	39876941	3.036	6500	5602
1999	2145.10	3557	41067266	2.941	6500	6070
2000	2219.42	3696	42210756	2.746	10296	6600
2001	2268.29	3724	43295660	2.538	11412	6916
2002	2407.45	3444	44339692	2.383	12068	7321
2003	2548.03	3743	45356387	2.267	15773	7869
2004	2646.73	4001	46368386	2.207	16139	8682
2005	2737.11	4139	47393548	2.187	17386	9404
2006	2864.78	4028	48433711	2.171	16276	9789
2007	3053.12	3912	49450701	2.078	21191	10051
2008	3034.84	4050	50468799	2.038	16517	9964
2009	3116.58	4037	51513162	2.048	19535	10908
2010	3259.40	4080	52589754	2.068	21720	11995
2011	3314.36	4054	53702091	2.093	23268	13197
2012	3369.12	3387	54849058	2.113	20199	14463
2013	3131.80	3113	56009792	2.094	18592	15422
2014	3488.00	3471	56812925	1.900	21670	15946

One of the main descriptions in statistics is defining the correlation and the relation between two variables. In general, the intensity of dependency of two variables with each other is called correlation and there is a possibility that in addition to dependency intensity the researcher may also need to be informed of correlation direction. In statistics there are a number of various correlation coefficients that each measures the rate of correlation between two variables taking into accounts the type of data and the conditions of variables. In general correlation coefficient varies from -1 to 1; the relation between two variables can either be positive or negative. There is some significance in correlation coefficient that must be mentioned. Correlation coefficient is a symmetrical relationship, the more the correlation coefficient proximate one the higher rate of variable dependency. However, it should be observed that this dependency is not to the significance of cause and effect and correlation coefficient does not definitely mean cause and effect. However, if other variables effect the dependent variable then there is a probability that each covariance shares an independent variable and have wrong effect on correlation coefficient with independent variable. Generally, in correlation coefficient this can be studied for the existence of nonlinear relation between two correlated variables while correlation coefficient shows this inaccurately.

From among correlation coefficient types, Pearson's, based on covariance of two variables and their standard deviation was applied for this research to evaluate and calculate in accordance with Pearson correlation coefficient.

$$P = \frac{\mathrm{cov}(x, y)}{\sigma_x \sigma_y}$$

In this section, initially the issue is studied to discover the effect of changes on independent variables over changes on dependent variables; in order to perform the investigations, the data in Table 3 were categorized such that each column belong to one variable. Next, independent variables correlation was compared with dependent variables. The following Table represents the corresponding values of correlation (C) and P-value (P):

TABLE 3. THE EFFECT OF INDEPENDENT VARIABLE CHANGES OVER DEPENDENT VARIABLES

Variable	Response 1		Response 2		Total	
	C	P	C	P	C	P
Steel Consumption	0.9042	0.0000	0.9005	0.0000	0.9049	0.0000

Steel Production	0.9776	0.0000	0.9780	0.0000	0.9809	0.0000
GDP per capita	0.9763	0.0000	0.9721	0.0000	0.9769	0.0000
Urban population growth	-0.8554	0.0000	-0.8620	0.0000	-0.8591	0.0000
Crude Oil Production	0.0017	0.9942	0.0028	0.9906	-0.0046	0.9847
Urban population	0.9806	0.0000	0.9680	0.0000	0.9807	0.0000

Discussion & Conclusion Analysis

The inputs of neural network used in this research are shown in table 4. It is important that in this study using available data and the considerations of time series for each target variable, the rate of produced energy for the current year and the previous year were also added to select inputs in the previous section.

TABLE 4. THE INPUTS AND OUTPUT OF NEURAL NETWORK IN THIS STUDY

Output	**Input 1**	**Input 2**	**Input 3**	**Input 4**	**Input 5**	**Input 6**	**Input 7**
Power consumption in the next year	Power consumption in this year	Power consumption in the previous year	Steel Consumption in this year	Steel Production in this year	GDP per capita in this year	Urban population growth in this year	Urban population in this year

The number of input nodes and also the neural network output can be determined via offered network mapping. In this research since there are seven independent variables and one dependent variable, the number of nodes in the input layer is 7 and the number of nodes in the output layer is one. However, a suitable method to determine the numbers of hidden layers and nodes in each layer and also the type of transfer function is use of trial and error; such that if the numbers of hidden layers and neurons of each layer are insufficient the network will not present right optimal converge solution and if the numbers are more than what required, the network becomes unstable.

In this article, in order to design the best network, several plans were examined. The results show that four layer network which two layers are hidden gives the better solution. In the network ten nodes in the first hidden layer and 5 nodes in the second hidden layer were used. In the network plan the arrangement of 7-10-5-1 was used to reach the lowest MSE. Also, different types of conversion functions were examined with various layers and the conversion of hyperbolic tangent function for various layers was attained as the better solution. The neural network developed in this study was used to find the pattern of relation between data set for different power generation methods. Figures 4(a1, a2, b1, b2) show the pattern for heater power generation method. Figure 4(a1) shows the time series of network attained from the train data and the train net; And Figure 4(b1) shows the test data and test net for response1 respectively. The figures show that there is a near correlation between train data and train net. Also, Figure 4(a2) shows the scatter plot of train data and train net omitting the time dimension; And Figure 4(b2) shows the same comparison between the test data and test net. The same method was used for other electricity power generation methods in Iran.

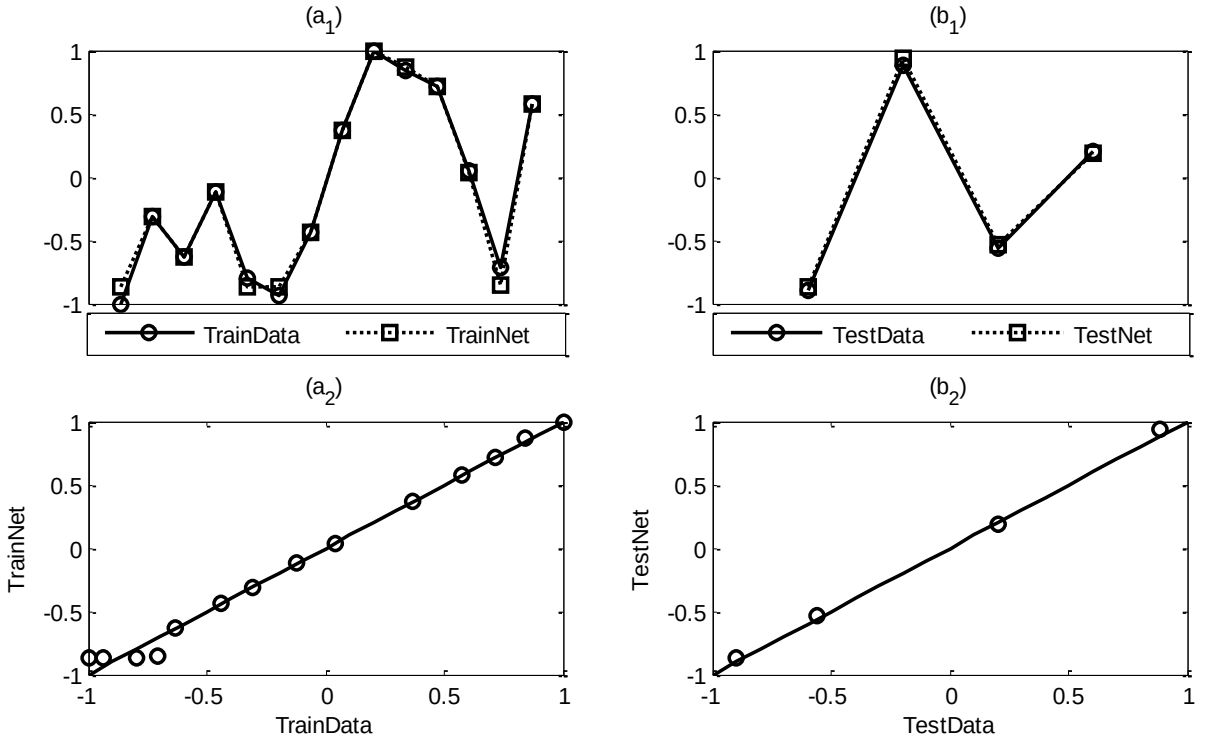

FIG. 4 - DEMONSTRATION OF TEST & TRAINING DATA PROCESS AND HEATER POWER GENERATION METHOD

In Figure 5 a survey on test & training data collection for establishing neural network (ANN) is presented. In designing this information network, the total national power generation is utilized and Figure 8b shows the combination of all data for different power generation methods

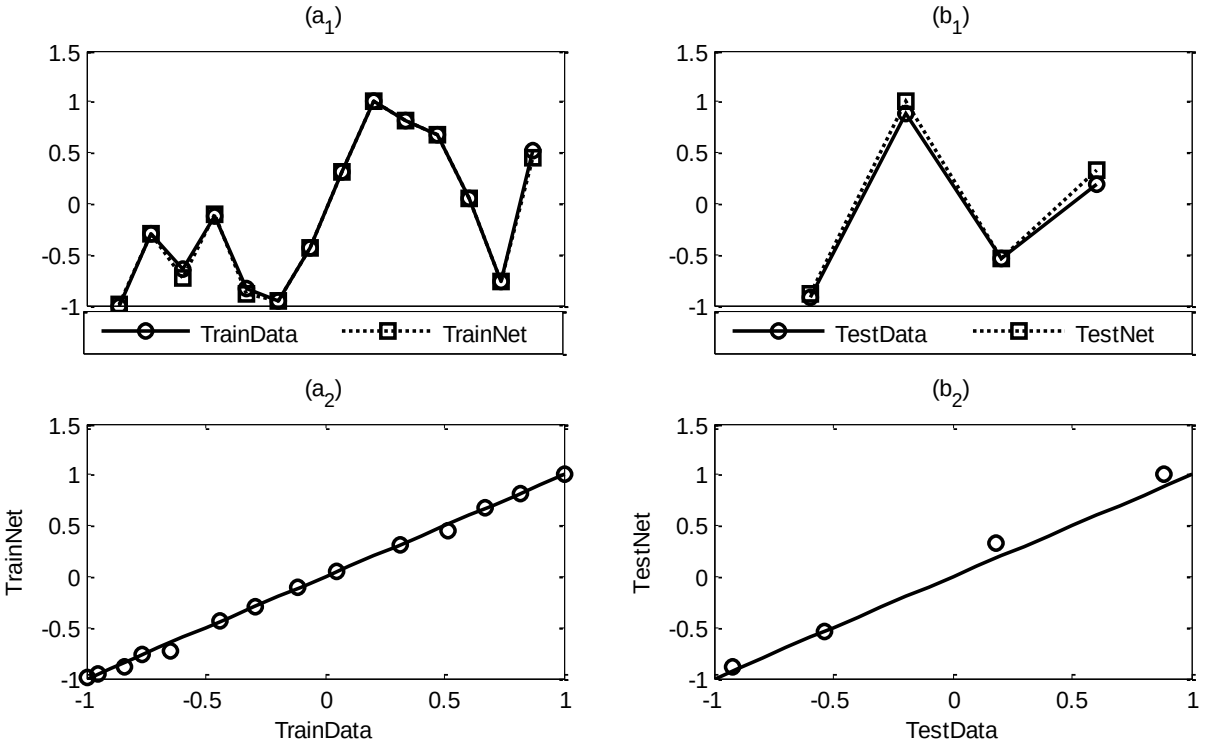

FIG. 5 - DEMONSTRATION OF TEST & TRAINING DATA PROCESS FOR ALL METHODS OF POWER GENERATION IN IRAN

In all prediction methods the error and the uncertainty is unavoidable. Therefore, to establish a predicted model and select of the best model among various existing ones in a time series an index is required to find the certainty of acceptance or rejection of adopted predicted model. In general, the more proximity of actual series (yt) to predicted value (y^t) shows the more model accuracy. Therefore, the quality of a model is evaluated on the basis of predicted error as follows:

$$e_t = y_t - \hat{y}_t$$

Prediction error is caused by ignore of one or more components of time series predictions like trend, seasonal and cyclical effects. Also, the error could be due to irregular and erratic fluctuations in data source. In this case, total errors that can be observed by a prediction method is determined as follows:

$$SE = \sum_{t=1}^{n} [y_y - \hat{y}_t]$$

where n is the number of observed duration.
This error can be determined in a different method using the mean squared error (MSE) as follows:

$$MSE = \frac{\sum_{t=1}^{n} [y_y - \hat{y}_t]}{n}$$

In Table 5 the obtained MSE for each test and training data is demonstrated. It is worth mentioning that test and training dataset is randomly selected thus data set 3, 7 and 17 are selected as data test and the rest are considered as training data. Results in Table 5 shows that the determined error using the test data is acceptable.

TABLE 5 – MSE VALUES OBTAINED FROM TEST AND TRAINING DATA

Method	Train MSE	Test MSE
Response 1	7.6028e-05	0.0029
Response 2	9.7939e-05	0.0023
Total	9.6952e-04	0.0086

Using the network designed in this study and based on real data collected in 18 years, the feasibility of the types of energy production and the rate of production for the coming year is anticipated. Table 6 indicates the predicted values for the generation methods of electricity in Iran in 2015.

TABLE 6. PREDICTED VALUES OF 2014 FOR ELECTRICITY GENERATION METHODS (KW).

Method	2015
Response 1	60148.3031
Response 2	11696.8009
Total	72826.0896

As in the methodology used was explained, for predicting the energy producing with various methods in 2025, data pattern should be assumed steady i.e. without a significant change up to 2025. Therefore, a proper regression method can be used to estimate the input data for neural network.
It must be noted that when an equation is solely used for predictions there may not necessary to have a cause and effect relation. In this case, it is required to have the reliable data relevance to use a proper regression model. The followings methods are used as the Multi-purpose regression models:

- Data description
- Evaluation of parameters
- Prediction & estimation
- Control

Therefore, it is probable to use the regression models for controlling. However, when a regression equation is applied to control an objective, the variables should be randomly related. In this research the following regression method which is a polynomial model is used to appraise the required inputs for forecasting the data for year 2025. Coefficient of each relevant equation is given in Table 7.

$$f(x) = b_0 + b_1 \times x + b_2 \times x^2$$

TABLE 7. COEFFICIENT FOR EACH EQUATION

Method	b_0	b_1	b_2	R-square	Adjusted R-square
Response 1	17180	870.6	72.75	0.9912	0.9901
Response 2	1156	159.7	19.91	0.9746	0.9716
Total	18400	1017	94.18	9933	0.9926
GDP per capita	1833	81.34	0.06988	0.9608	0.9662
Steel Consumption	2084	1690	-35.53	0.9129	0.9027
Steel Production	5257	47.29	25.29	0.9843	0.9825
Urban population Growth	3.24	-0.1225	0.003002	0.8777	0.8633
Urban population	35400000	1123000	-2637	0.9997	0.9997

In this study the coefficient of determination, denoted R squared, is used to indicate how well the input data are fitted to the introduced statistical model. Table 7 shows that the regression models in this study are accurate because the R-squares and Adjust R- squares determined are higher than 0.87 and 0.85 relatively.
Figures 6 (a-e) and 7 (a-e) clearly show the fitness of data and curves obtained from regression equations are fairly adequate.

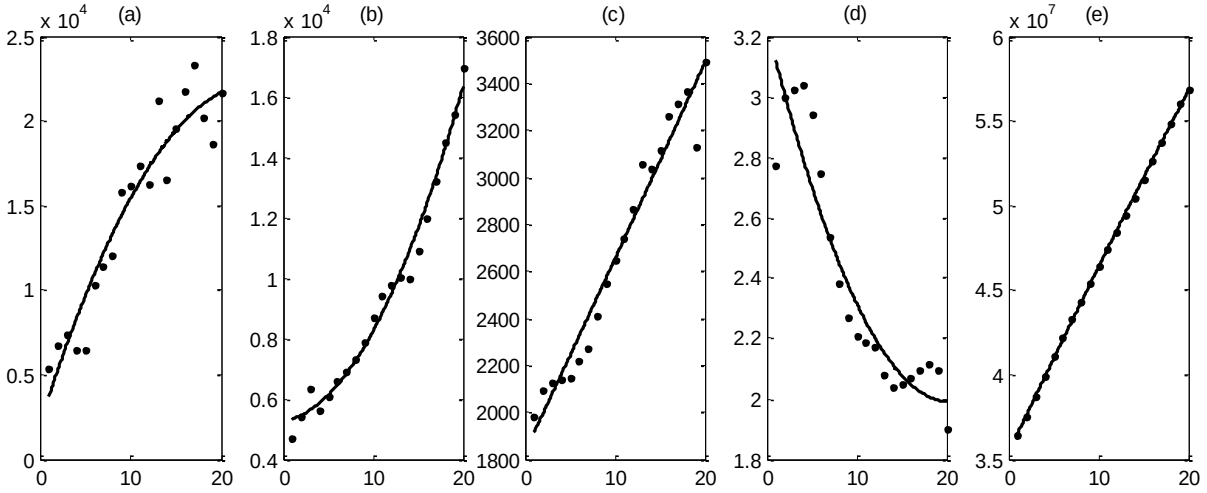

FIG. 6 – REGRESSION EQUATION FOR EFFECTIVE VARIABLES ON POWER GENERATION PROCESS (A) STEEL CONSUMPTION (B) STEEL PRODUCTION (C) GDP PER CAPITA (D) URBAN POPULATION GROWTH (E) URBAN POPULATION

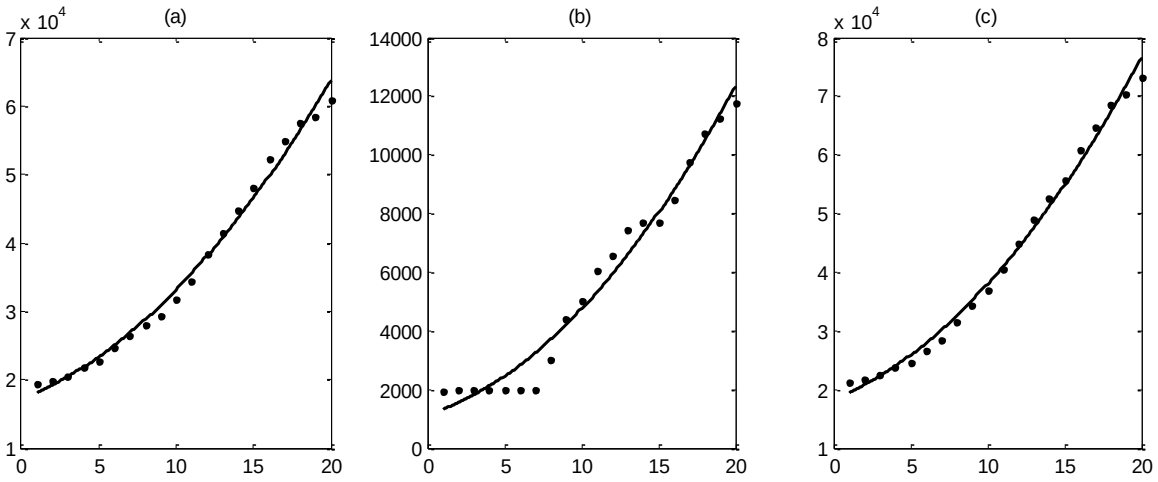

FIG. 7 – REGRESSION EQUATION FOR VARIOUS POWER GENERATION METHODS (A) RESPONSE 1 (B) RESPONSE 2 (C) TOTAL

Using the inputs obtained from regression models, the electricity generations between 2015 and 2025 are estimated by the developed neural network. The results of power generation methods in the predicted decade are presented in Table 8.

TABLE 8. THE ELECTRICITY GENERATION PREDICTED IN 2025 USING THE DEVELOPED NEURAL NETWORK (KW).

Method	**2025**
Response 1	103022.546
Response 2	22531.6043
Total	128584.462

Since Iran is an arid country with low precipitation, the increase of hydropower electricity is not probable. Also, past experiences and prolongation of nuclear power plant operation in Iran (34 years) state that increase of power generation using the atomic method during the following decade is not easily feasible. Also, the presented information by the Iran Ministry of Energy [23] states that during 1967 – 2014 capacity of power generations using renewable methods (non-atomic) limited to 193 MW. Consequently, it is anticipated that within the next future decade the tendency to develop the power generation in Iran using the renewable resources is still constrained because the fossil energy in Iran is quiet cheap.

Thereupon, the share of production increase in hydropower sectors and the two other methods of gas and steam turbines are subdivided. In consideration of the fact that by looking at Table 8 the ratio of heater to gaseous is 0.2290 and also since it is assumed that the rate of hydropower and other methods will remain stable, Table 9 in respect to power generation anticipation will be then replaced to Table 8.

TABLE 9. POWER GENERATION PREDICTION FOR THE YEAR 2025 (KW)

Method	**2025**
Response 1	113769.150
Response 2	11785
Total	128584.462

Nowadays Iran is producing the electricity using different resources i.e. gaseous, steam, nuclear and renewable resources. However, the low price of fossil fuel in Iran and the time consuming of some power plant constructing affect the outcome of investment in future of power plan in the country in the remaining time of vision documentary. On the words, it seems that fossil fuel is inexpensive and highly in access in Iran. This may have developed the urge of investment on Iran power generation using oil and gas; the said sole 0.1% of total national capacity was generated using various methods like solar energy, wind energy and geothermal [15]. That is why the present study endeavors to estimate the required costs of investment on power industry principally on the basis of fossil fuels.

Needed Estimated Investment to Generate Electricity

Based on estimated prices in [19, 20] for electricity generation, the require investment for various methods per kilowatt is demonstrated in Table 10.

TABLE 10. THE INVESTMENT FOR PRODUCING ONE KILOWATT ELECTRICITY IN US DOLLARS

Response 1	Response 2
29.4150	18.65

Using Tables 9 & 10 the total investment for electricity generation in Iran 2025 is estimated as shown in Table 11.

TABLE 11. REQUIRE INVESTMENT FOR ELECTRICITY IN YEAR 2025 IN US DOLLARS

Response 1	Response 2
3346519.547	219790.25

Using results in Tables 6 & 9 the average rate of electricity production is calculated in each method. The annual average for the steam method is equivalent to 20804.776 kilowatt electricity, for the gaseous method is 56397.094 kilowatt, for the hydropower method is 10231.668 kilowatt and for other methods is 17926.75 kilowatts. Using Table 10 the required average investment for power generation can be calculated for various methods. The average required investment for power generation by the steam method is 444390.02, by the gaseous method is 2113199.1, by the hydropower method is 64766.458 and by other methods is about 334333.88 hence, it can be concluded that the total required investment until 2025 for power generation in Iran is equal to 32526411.48 US Dollar.

CONCLUSION

Economy of Iran is growing due to having the young and educated people who want to use and enhance the great potentials of mining and industries of Iran. Therefore, Iran is going to increase generation capacity of electricity, and this issue depends highly on extensive investments in this term. In the absence of necessary investment, the country must resort to energy import or otherwise Iran will face to a large-scale blackout. In view of the fact that most neighboring countries are politically unstable and insecure, the energy import is not reliable for the future decade in terms of industry, agriculture and household use. Therefore, this survey, by application of developed methodology, is aimed to determine the required investment in electricity generation in Iran. Therefore, initially the effective factors of Iran power generation were identified based on the rate of dependency to target variable factors. These factors are GDP per capita, urban population (as the main electricity consumer), urban population growth (as the stimulus of consumption), steel consumption (as the factor of development) and steel production (as the main electricity consumer)

A neural network was used combining with a regression method. The considered inputs in designing the neural network were prepared using the identified factors and trends of electricity production data during the last 18 years in Iran. The developed neural network in this study combining with the regression equations predicts the power generation for year 2025 as the vision of Iran. The past overview of investment in Iran electricity industry demonstrates the analysis of national power generation. Based on this analysis the generation of electricity using the atomic energy in the next decade is not feasible because ten years is not adequate to construct a new atomic power plant. In addition, other renewable sources of energies in Iran are not actually economic because fossil fuels are fairly cheap in Iran. Hence, investment process of coming decade is tended to gas and steam power generation in electricity industry. Therefore, the investment equivalent to 32526411.48 US $ must be considered by Iran's government in the power plant for the next decade.

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