SAÜ Fen Bilimleri Enstitüsü Dergisi
2 (1997) 111-114

PREDICTION OF DAILY ACTIVE AND REACTIVE ENERGY CONSUMPTION FOR CITY CENTER OF ADAPAZARI BY ANN

Etem KÖKLÜKAYA

Dept. of Electrical and Electronics Eng.
Sakarya University, Esentepe, Sakarya, Turkey, TR-54040

ABSTRACT - Artificial Neural Network (ANN), is used in prediction of energy and load, as it is used in many different areas of electric power system. Energy consumption usage center has non-linear variation characteristic. Such as these non-linear variation can be predicted very well by ANN. In the present study, it is carried out the predicting of active and reactive daily energy consumption for Adapazari. Energy consumption to next day is predicted by using the data belong to yesterday. In the simulations, backpropagation algorithm is used.

I. INTRODUCTION

Increasing the energy need brought into action that analysis of load prediction in stage of electrical energy establishment planning and in management of energy service is very needed. Having been understood the importance of prediction in reliable and economically management of energy . These studies are carried out by artificial intelligent methods using statistical data [1.2].

As energy demand of consumer has non-linear structure. It could be encountered some difficulties in the analyses. However, the fact that it couldn't be determined certainly effects of factors affecting the energy demand are bringing more complexity in the analyses. Because ANNs are model that learn non-linear variations, they have some advantages in load prediction over conventional methods [2]. The most important superiority of ANN is that it constructs its model by learning the informations by experiments or observations for any problem [3]. Since the years of 1980s, applications of ANN to power systems have increased with parallel to developments of ANN. It is possible to find out a lot of researches in the literature[3,4].

II. ARTIFICIAL NEURAL NETWORKS

ANN is a model that is developed by being inspired from the brain of human. An ANN is a computational structure whose model is loosely based on biological process. There are two basic features that distinguish neural networks from other types of computing namely; 1-) they are adaptive or trainable and, 2-) they are highly parallel. An ANN can be either static or dynamic in character and can exhibit one or more several possible interconnections such as full or sparse feed forward and/or feedback.

The special type of ANN that we use to emulate behavior is a layered feed forward network. This type of ANN has been used successfully in several experimental applications. In this type of network there can many hidden layers in between the input and the output but every unit must send its output to layer higher than its own and must receive its input from layers lower than its own. The network, as it is currently used, is trained by adjusting the numerical values of the weights between each unit by means of some optimization algorithm. One such algorithm is termed back propagation and is conceptually generalization of a least mean square algorithm. More specially, feed forward networks are used with one hidden layer. Mathematically this type of network can be described following equation:

$$f_n(x) = \sum_{k=1}^{n} \alpha_k . \sigma_k . (w_k . x + b_k) \quad (1)$$

Where σ is a so-called sigmoidal function, n is the number of sigmoidal function in the hidden layer, x is the input, b is the bias, and α and w are the weights[5]. A schematic diagram of this type of network is shown in Figure 1. Note that d is the dimension of the input x, and b_k is not shown .

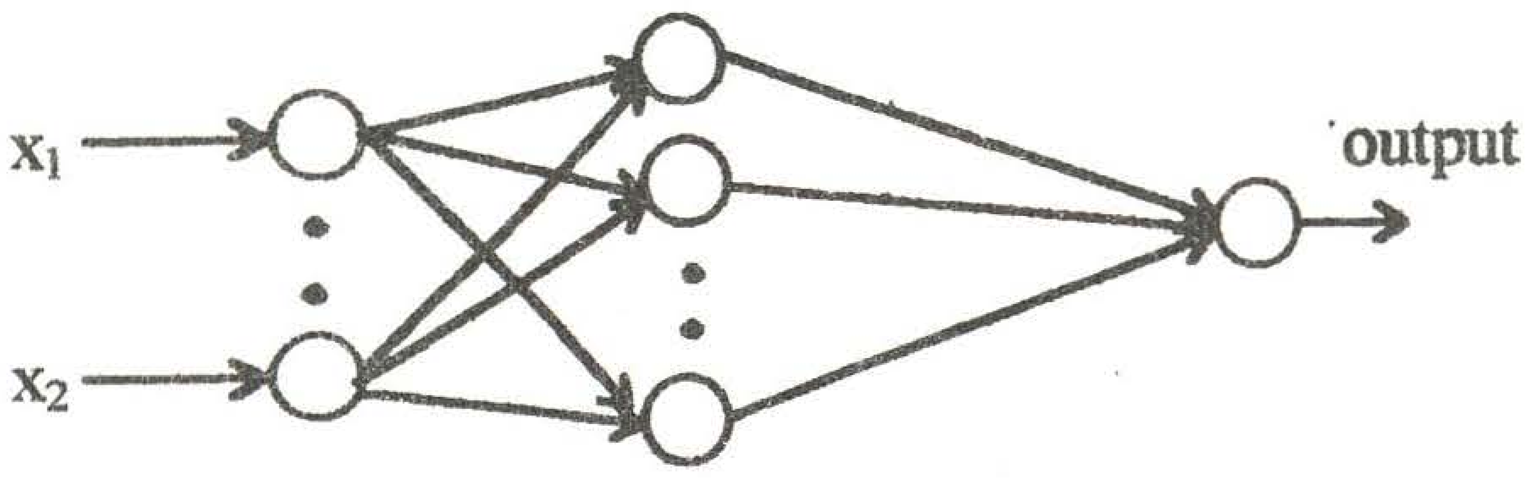

Figure 1: Feed forward ANN with one hidden layer

In this paper, it adopt that the definition of a sigmoidal function $\sigma(z)$ as a bounded measurable function on the real line for which $\sigma(z)\to 1$ as $z\to\infty$ and $\sigma(z)\to 0$ as $z\to -\infty$ The sigmoidal function used is following form in this paper.

$$\sigma(z)=\frac{1}{1+e^{-z}} \tag{2}$$

III. MODELLING BY ANN

In this study, it is aimed to teach daily total active and reactive energy consumption to the artificial neural network. For this aim, three kinds of model are considered, and carried out. In the Figure 2 only active energy is taken output of the first model given its block diagram; in the Figure 3 only reactive energy; and finally in the Figure 4, both active and reactive energy are given as output of the model 3. In all models, only one hidden layer is used. Layer cell number (neuron) and amount of iteration have been different for each model.

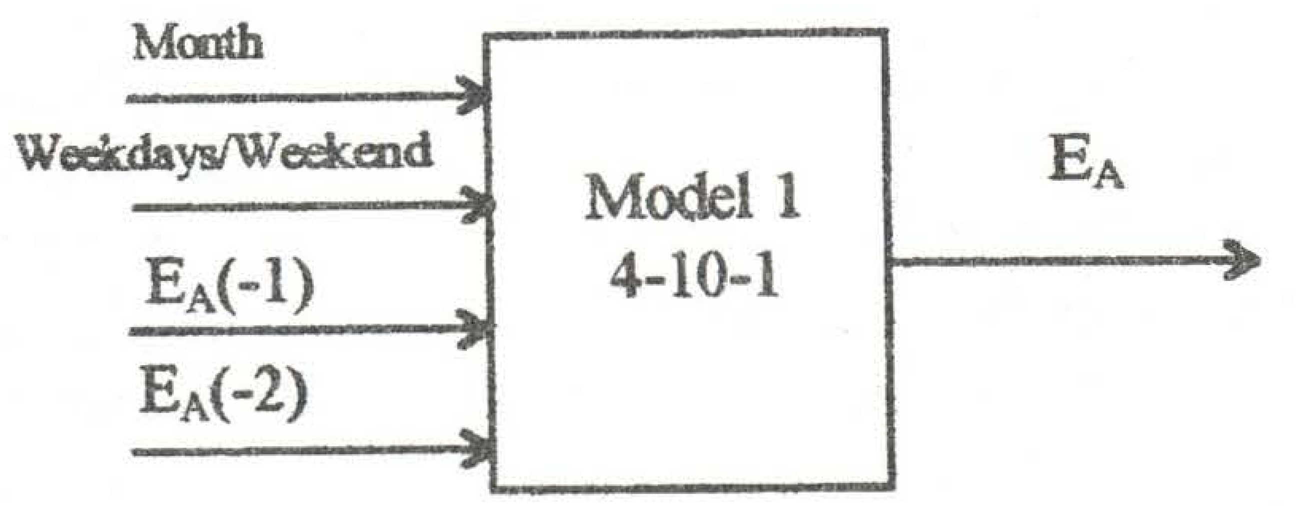

Figure 2. The first model to have been taught only active energy

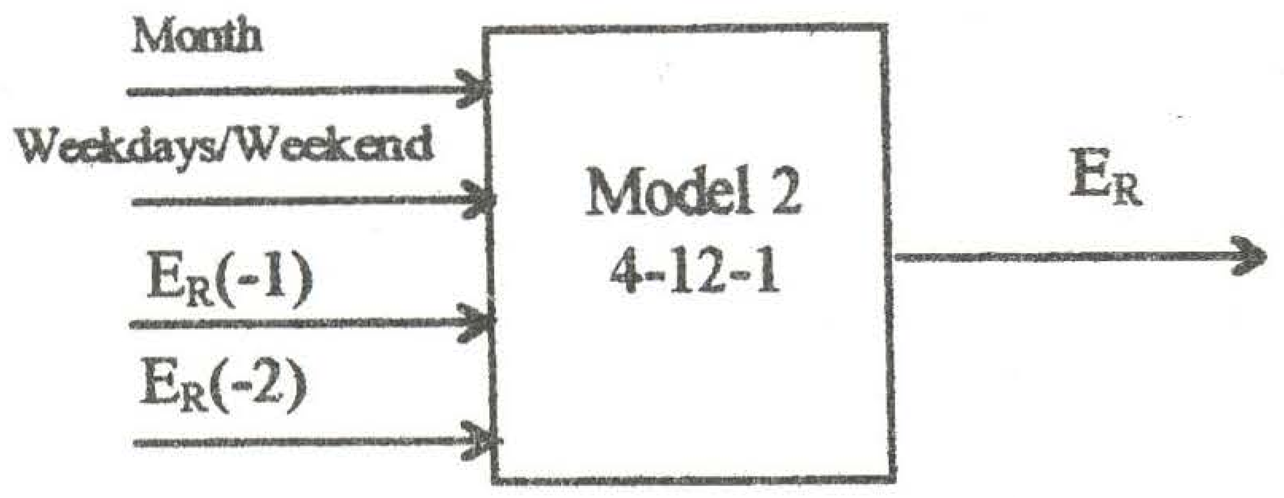

Figure 3. The second model to have been taught only reactive energy

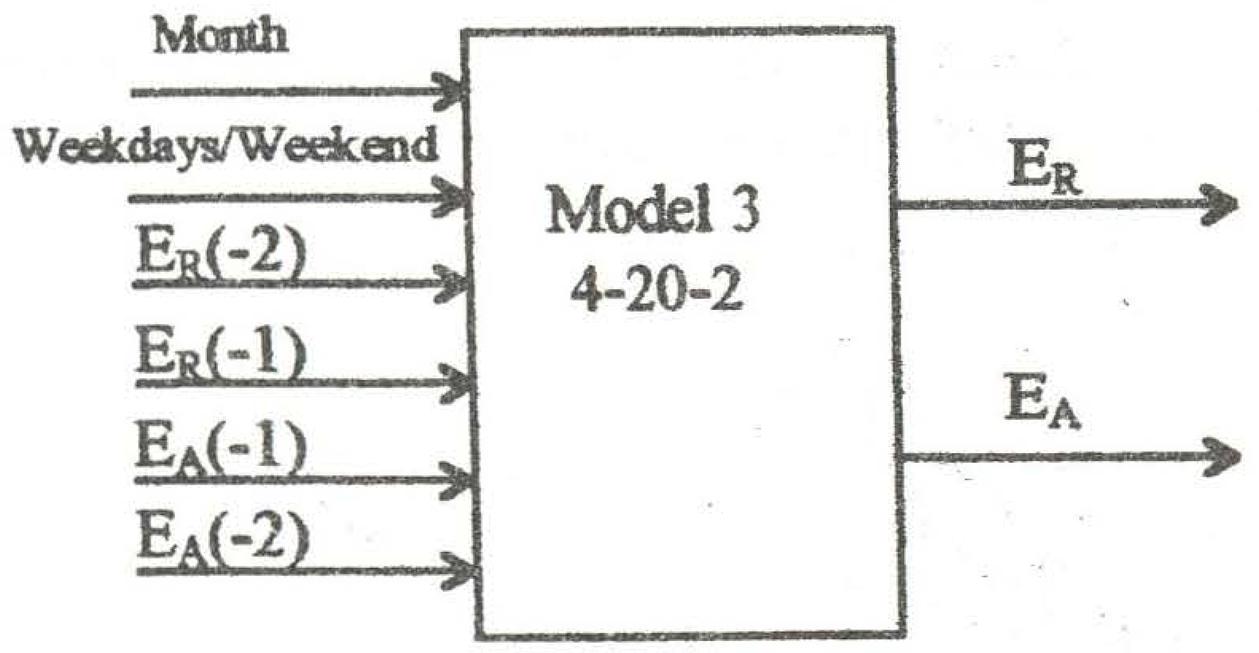

Figure 4. The third model to have been taught both active and reactive energy

The values $E_A(-1)$ and $E_A(-2)$,used in these models, were taken one and two days ago. By using these values, it is expected the predicting energy consumption for the next day. So, it is expected the predictions for short periods for the future. In the study, values used in the level of learning and test are taken from the regional directorate of TEAS-KBA (Turkish Electric Generation and Transmission Company - Northwest Anatolia Load Distribution Center) in Adapazari, and the values cover those belong to city center of Adapazari. They don't cover those belong to surrounding towns and units. In the learning studies, it is arrived at the results given below.

<u>Model 1 :</u>
Architectural Structure : 4L-10S-1S
Learning Rate: 0.35
Momentum: 0.5
Error: 0.001
Iteration: 25500

<u>Model 2 :</u>
Architectural Structure : 4L-12S-1S
Learning Rate: 0.3
Momentum: 0.5
Error: 0.0018
Iteration: 24000

<u>Model 3 :</u>
Architectural Structure : 4L-20S-1S
Learning Rate: 0.25
Momentum: 0.5
Error: 0.0023
Iteration: 30000

IV. RESULTS

In the present study, it is carried out daily electrical energy consumption predicted for Adapazari by ANN. So, approximate model giving daily energy variation is established for Adapazari. This model facilitates evaluation of energy consumption data for Adapazari, and planning for future works. More suitable results are obtained from the two of the three models established compared to third one. The reason for this is that active and reactive energy consumption has high gradients. In the third model, it is desired to learn to the computer two non-linear variations together, but worse results have been obtained than those of two models. However, the testing error is also small for third model. From these models, it is observed that separate model for active and reactive energy consumption decreases the errors. Graphics of the results are given in appendix.

V. REFERENCES

[1] Box, G., and et al; Time series analysis forecasting and control, Holden-Day, San Francisco, 1976.

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[3] Esiyok, E., Yilmaz, A., S., and Bayrak, M.; Yük dağıtım merkezlerinde yapay sinir ağlari ile kısa dönemli yük tahmin analizi, 1. Zeki İmalat Sis. Semp., Sakarya, 1996

4] Lee, K., and Park, J.; Short term load forecasting using an ANN, IEEE Trans. on Power System, May 1991.

[5] Ku, B., and et al; Power system dynamic load modelling using artificial neural network, IEEE Trans. on Power Systems, Vol. 3, No. 2, pp, 1868-1874, Nov. 1994.

VI. APPENDIX

In all simulations, data used in training and testing level are normalized between 0 and 1. Normalization is done by following equation.

$$Xnorm = \frac{Xreal - X\min}{X\max - X\min} \qquad \text{(A-1)}$$

Simulation results are given following figures.

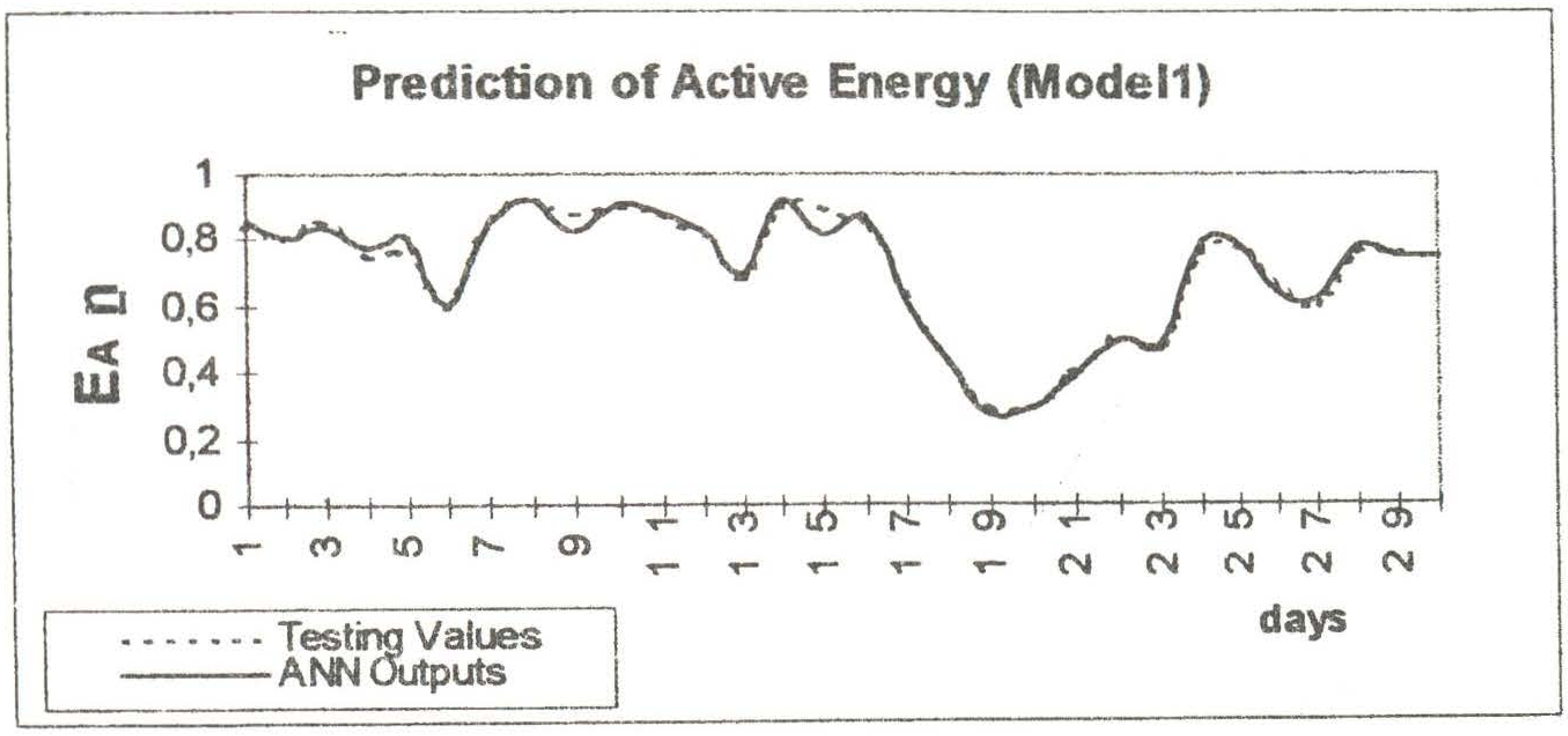

Figure A1. Predictive Results of Active Energy for Model 1

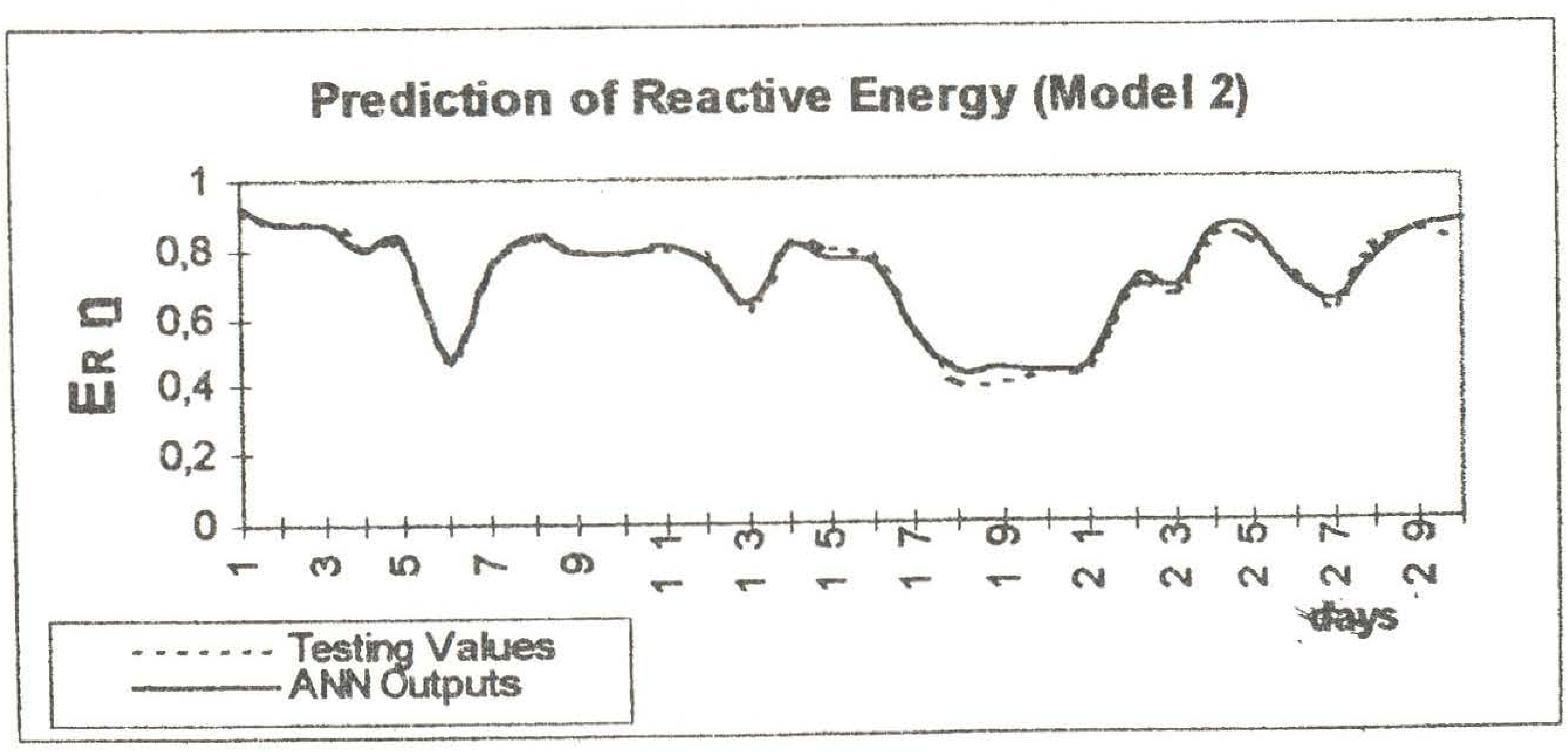

Figure A2. Predictive Results of Reactive Energy for Model 2

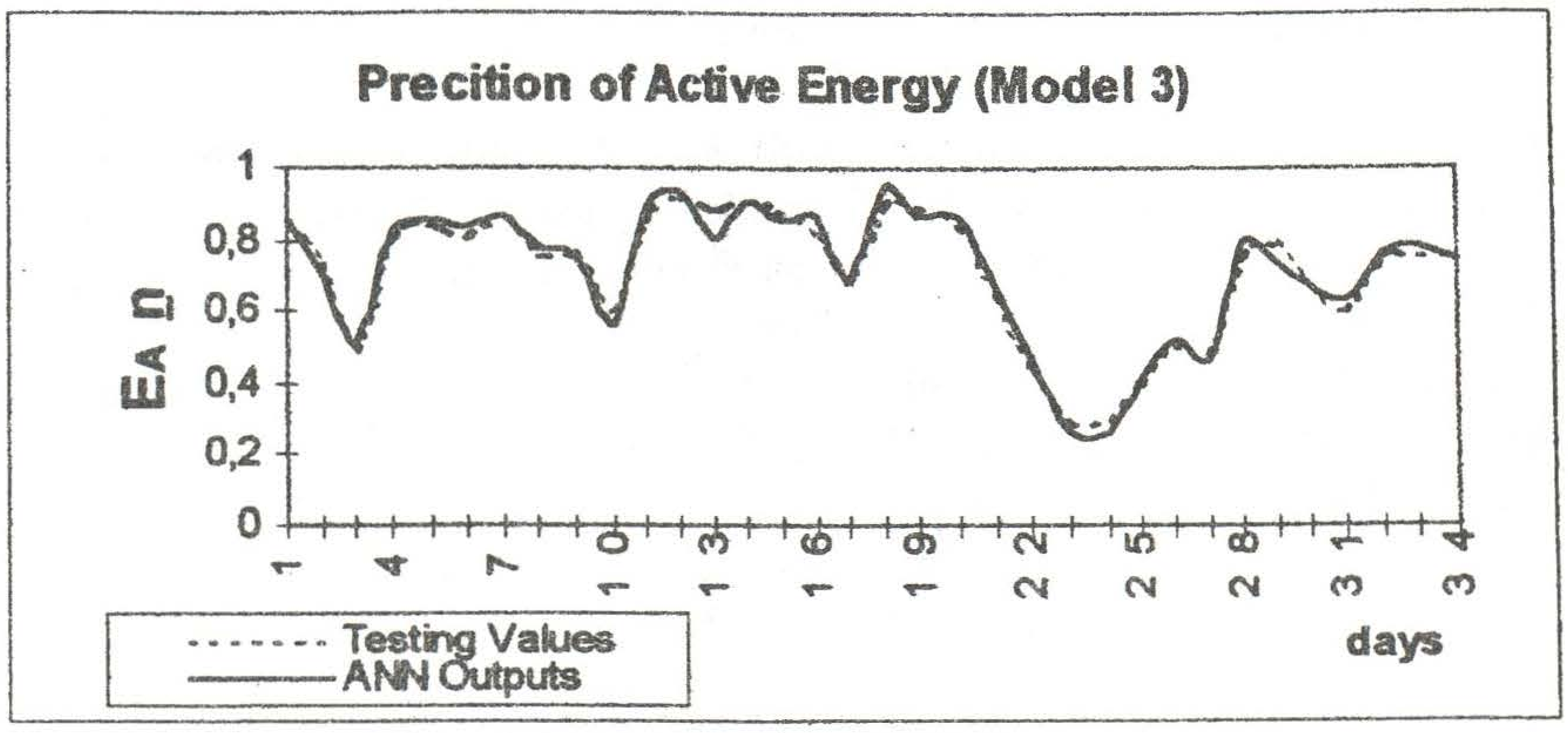

Figure A3. Predictive Results of Active Energy for Model 3

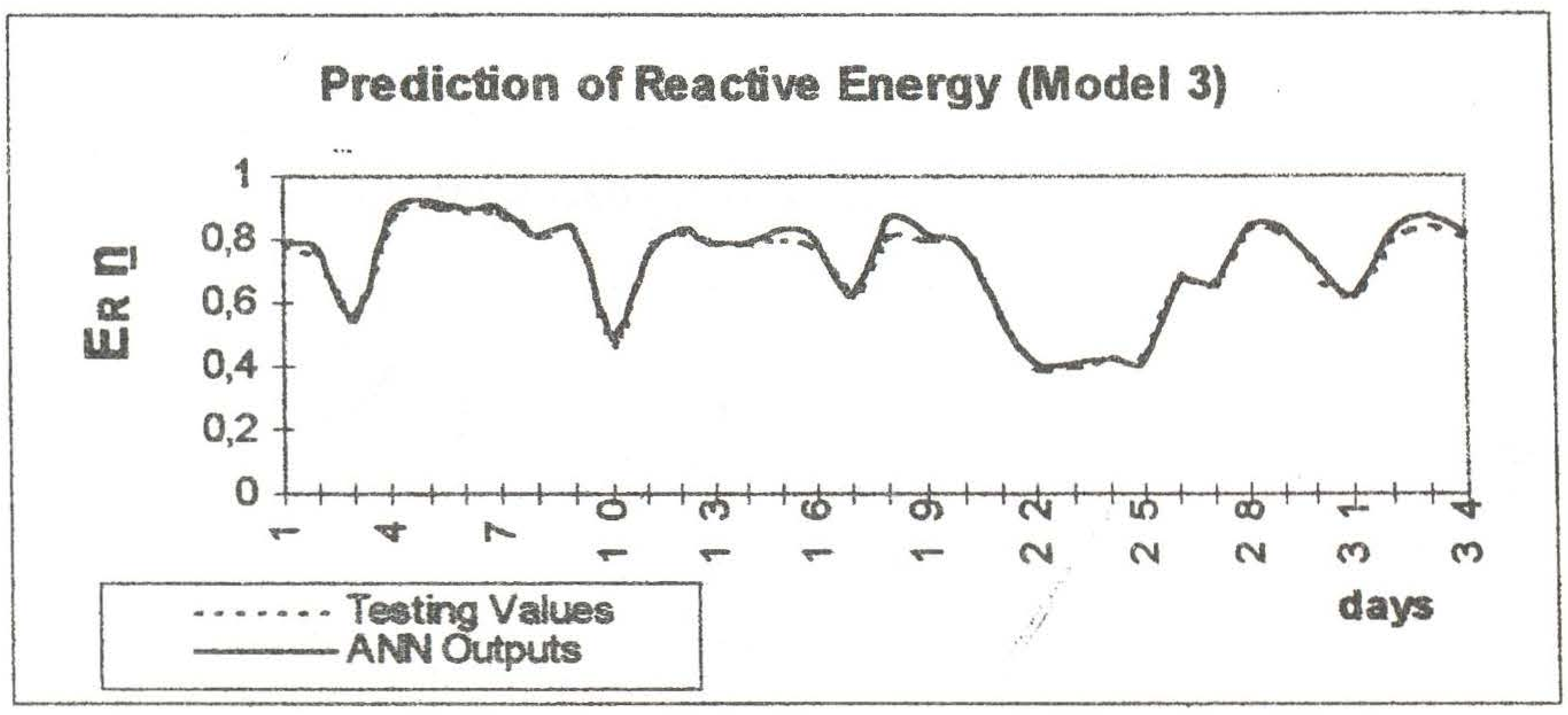

Figure A4. Predictive Results of Reactive Energy for Model 3