# Optimal Combined Load Forecast Based on the Improved Analytic Hierarchy Process

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[1]*Abstract*--**Different forecasting methods can lead to very different results in power system load forecast. In order to improve forecasting accuracy, combined forecasting methods have been introduced in solving the engineering forecasting problems.**

**In this paper, the conception of soft method is first presented in power system load forecast. The computing and analyzing methods in soft science such as decision-making analyses have been introduced to solve load forecast that are unstructured problems of multi-factors. The combined forecasting problem is treated as multi-hierarchies and multi-factors evaluation by composing qualitative analyses and quantitative calculation. In addition, the experiences and judgments of experts will be collected to implement judgment matrices in group decision-making.**

**The soft method based on improved analytic hierarchy process (AHP) is proposed to carry out long-middle term load combined forecast in this paper.**

**A hierarchy structure has been established by analyzing various factors that affect the load forecast. It is the key to determine the combined weight coefficients in the optimal combined forecasting method. Fuzzy complementary judgment matrixes of pairwise comparison will be formed by expert in each hierarchy and be converted to a fuzzy consistent matrix. The eigenvector can be calculated using its general formula and be regarded as weight coefficient in combined forecasting.**

**The combined forecast methods based on the improved AHP is of clear hierarchy structure, sufficient judgment information and simple calculation formula. The forecasting examples show that this method is practical, convenient and accurate.**

*Index Terms*-- **AHP, Fuzzy Judgment Matrixes, Optimal Combined Load Forecast, Soft Method**

## III. INTRODUCTION

It is important and foundational to forecast power load for electrical power system. The accuracy of short-term load forecasting affects the operation, dispatch and economy in power system, but the accuracy of long-term electric power load forecasting will influence the planning of power system, the speed of building, even large energy decision problem.

Therefore, it is important to advance the accuracy of forecast for electrical power system.

There are many methods to forecast power load. For example, linear or curvilinear regression analysis, elasticity coefficient, grey theory, neural network, fuzzy forecast and etc. These forecast methods are based on the history statistics data and investigate data, research the regulation of load change. Their main idea is to establish the mathematical optimal model for forecasting, intend to match the data, and make predict error least, and attain superior forecast result. The forecast results obtained from the different forecast methods may very different. Which method or which forecast result can be agreed upon? For the more accurate and satisfactory forecast result can be obtained, many forecasting method mentioned above are integrated and forms the combined forecasting method. Evolutionary programming and fuzzy comprehensive evaluation are current methods of combined load forecasting. The main idea of the former is still to minimize the error to historic data and pay attention to the match precision. This idea is identical to other forecast methods. The optimal math's programming is used in these forecast methods and deals with the forecast question to be quantitative and optimization. In this paper, they are called as hard methods that mathematics and optimal models are applied. Although evolutionary programming, neural network and GA are called as the soft calculation because of simulating biology technique, they are still clarified as hard methods of load forecasting because of its innate character belong to the mathematics optimal method. The hard methods depend on handling of history data and its mathematical expression excessively. Maths programming of single goal are adopted to match predicting functions and accuracy and to decide the combination weight.

But the change of power load is related with not only the history data, but also the development of the social economy, the adjustment of industrial structures, life and weather etc. The influence of various factors leads to any uncertainty. The various methods may not be applicable to various regions or various planning stages. Many load forecasting problems in practical usually are solved by experts with the judgment and experience. Therefore it can't represent the innate character of the forecasting problem completely to only make use of the mathematics programming. In hard methods it is be devoid of the analysis, judgment and control to forecasts and results.

In this paper, soft method is presented to carry out combined forecast for the long-middle term electrical power load, through integrating different forecast methods, combining the mathematics method and expert's experience and using the intellection of the decision maker sufficiently. The combined load forecast problem is settled to the decision-making problem through combining the quantitative calculation and qualitative analysis. The structure of hierarchy process for the combined load forecast is established. Multi-criteria factors are counted. Expert's judgments are combined. The improved analytic hierarchy process (AHP) is adopted in

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the long-middle term electric power load combined forecast.

The soft method of electric power load combined forecast is account for not only the highest fitting accuracy (HFA), but also suitability of methods to actual state (SMS) and believability of forecasting results (RFR) as the criteria of decision adjudicate. HFA is same as the object of hard methods. Different hard forecast methods and their different results are analyzed synthetically. The forecasting load value of electricity power MWH and MW in further years can be recommended according to the synthetic analysis. The procedures of analysis, inference, adjudicate and calculation can be treated with the multiple criteria decision-making.

This paper is organized as follows: In the introduction, the load forecasting methods are reviewed and the conception of soft methods is presented. In section II, hierarchy structure is established for long-middle term combined forecast of electrical power load. Section III introduces the improved AHP and forms fuzzy consistent judgment matrixes and calculates the eigenvector. Forecasting examples is given in section IV. Conclusions in section V.

## II. HIERARCHY ANALYTICAL STRUCTURE FOR LONG-MIDDLE TERM COMBINED FORECAST OF ELECTRICAL POWER LOAD

### *A. Hierarchy Structure of the Combined Forecast*

Hierarchy analytical structure for long-middle term combined forecast of electrical power load is established in this paper and shown in fig.1. There are three hierarchies in the hierarchy analytical structure, such as goal hierarchy, criteria hierarchy and candidate schemes hierarchy.

*1) Goal Hierarchy:*

The goal of making decision for combined forecast of power load in soft method is for obtaining the more satisfactory forecast result of electrical power load.

*2) Criteria Hierarchy:*

Criteria hierarchy may be regard as sub-objective hierarchy. Each criterion may be a factor that affects the total goal, but the degree of influence is different. The weights that each criterion influences total forecast goal will be calculated in this criteria hierarchy. In additional, each kinds of methods in candidate schemes hierarchy that will be combined are different important to each criterion in criteria hierarchy.

Criterion 1: Highest fitting accuracy (HFA) for history data. This sub-objective is consistent with the optimal objective of every kind of mathematics model in hard methods.

Criterion 2: Concordance with future economic development (CFE)

The factors, such as regulation of industrial structure and economy development in the future, will influence forecast problem in different degree, so this criterion is considered. At the same time, many forecast methods in scheme hierarchy are related with economy development differently.

Criterion 3: Suitability of methods to actual state (SMS)
The forecast method may influence forecast result. Different forecast methods may be suitable to different area. For example, linear or curvilinear regression analysis and elasticity coefficient can't be applied to forecast power load in a new developing area and the production value per unit consumption can't be applied to agricultural area etc.

Criterion 4: Believability of the forecast result (BFR)
Generally, the hard forecast methods in candidate schemes hierarchy only are used to calculate forecast results. But it is lacking to judge and control the forecast results. The forecast results from different forecast methods may very different, so experts and forecaster's experiences usually are used to confirm which method or result is more suitable and believable.

*3) Candidate Scheme Hierarchy:*

Candidate schemes hierarchy is composed of a set of forecast hard methods and their forecast results. Each hard method of forecast power load is regarded as a combined method in this paper, for example, linear or curvilinear regression analysis, grey GM(1,1), neural network, elasticity coefficient and the production value per unit consumption etc. and each result from hard method respectively is combined. When combined weights of each methods and results can be obtained, the combined forecast result can be calculated.

### *B. Decision-Making Analysis Method for Long-Middle Term Combined Forecast of Electrical Power Load*

The combined forecasting problem is treated as decision-making one of multi-hierarchies and multi-factors. The hierarchical structure is established for the combined forecast of power load with combining qualitative analyses and quantitative calculation. In addition, the experiences and judgments of experts will be collected to implement judgment matrices in decision-making. So it is called as soft model. This soft model can be processed through decision-making method such as analytic hierarchy process (AHP) method and fuzzy comprehensive evaluation (FCE) method etc. Due to characteristic of the hierarchy structure, the improved analytic hierarchy process (AHP) is adopted in this text, improving consistency of the judge matrix,

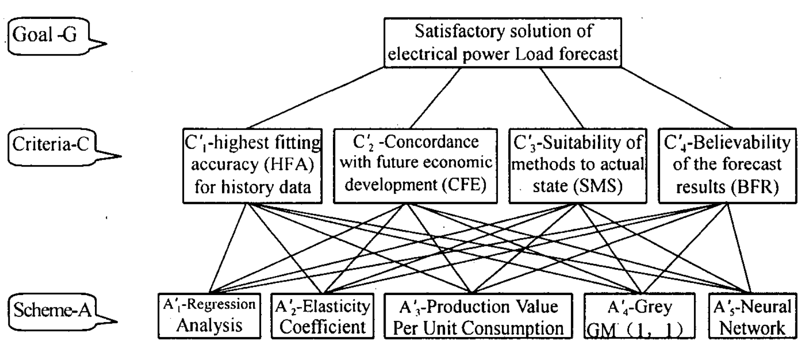


Fig. 1. Hierarchy analytical structure for long-term combined forecast of electrical power load

obtain the satisfactory solution of forecast problem.

The eigenvector derived usually in conventional decision-making analysis can be realized as priority vector. In this paper eigenvector will be applied as weight vector in combined forecast because the eigenvector reflects the important degree for each criteria or each forecast methods and results.

## III. IMPROVED ANALYTICAL HIERARCHY PROCESS (AHP) AND FUZZY CONSISTENT JUDGMENT MATRIXES

### A. *Review of basic Computation in Analytical Hierarchy Process*

Analytic hierarchy process (AHP) proposed by Saaty in 1970s is widely employed decision making analysis aid that models unstructured problems of multi hierarchies and multi factors in political, economic, social, and management sciences. This is the systematic way to handle the multiple factors one by one in the face of complexity, interdependence, and change.

*1) Hierarchical Structure:*

In AHP, unstructured problems are processed as hierarchical structure problem. According to the characters of system studied, the factors and their relations are clarified as hierarchies one by one. In this paper, the hierarchical structure for combined load forecast is showed as fig.1

*2) Judgment Quantification via Pairwise Comparisons:*

Assume there are $m$ criteria (sub-objectives) $C'_1, \cdots, C'_m$. For the main object G, if a person (expert) considers $C'_i$ more important than $C'_j$, then $c_{ij} = s_i/s_j$ with $s_i, s_j \in S$ and $s_i > s_j$. The numbers for the ratios will be taken from the set $S=\{1,2,3,\ldots 9\}$. The ratios $c_{ij}$ indicate, for this expert, the strength with which $C'_i$ dominates $C'_j$. Then $c_{ji} = 1/c_{ij}$, all $i,j$, with $c_{ii}=1$, $1 \leqslant i \leqslant m$. The judges give pairwise comparisons of criteria to produce a matrix $C$ that is $m\times m$ matrix whose entries are the ratios $c_{ij}$. $C$ is called a positive reciprocal matrix.

In additional, assume there are $n$ issues (schemes, candidates) $A'_1, \cdots, A'_n$ in another hierarchy. Pairwise comparisons judge matrixes between issues for each criteria $C'_k$ $(1 \leqslant k \leqslant m)$ can be written as $A_k$. $A_k$ $(1 \leqslant k \leqslant m)$ is shown as table I and is a $n\times n$ matrix whose entries are the ratios $a_{ij}$ and is a positive reciprocal matrix.

TABLE I JUDGE MATRIX OF PAIRWISE COMPARISONS BETWEEN ISSUES $A'_1, \cdots, A'_N$ FOR EACH CRITERIA $C'_k$ $(1 \leqslant k \leqslant m)$

| $C'_k$ | $A'_1$ | $A'_2$ | $\cdots$ | $A'_j$ | $\cdots$ | $A'_n$ |
|---|---|---|---|---|---|---|
| $A'_1$ | $a_{11}$ | $a_{12}$ | $\cdots$ | $a_{1j}$ | $\cdots$ | $a_{1n}$ |
| $A'_2$ | $a_{21}$ | $a_{22}$ | $\cdots$ | $a_{2j}$ | $\cdots$ | $a_{2n}$ |
| $\cdots$ | $\cdots$ | | | | | |
| $A'_i$ | $a_{i1}$ | $a_{i2}$ | $\cdots$ | $a_{ij}$ | $\cdots$ | $a_{in}$ |
| $\cdots$ | $\cdots$ | | | | | |
| $A'_n$ | $a_{n1}$ | $a_{n2}$ | $\cdots$ | $a_{nj}$ | $\cdots$ | $a_{nn}$ |

*3) Weight Computation:*

For the positive reciprocal matrix $C$ given above, let the eigenvalues, counting a root of multiplicity $m$-times, be $\lambda_1 \cdots \lambda_m$. There is a dominant (real, positive) eigenvalue that can be called $\lambda_{\max}$, so $|\lambda_i| < \lambda_{\max}$ for all $\lambda_i \neq \lambda_{\max}$. Also, $\lambda_{\max}$ is a root of multiplicity one. Corresponding to $\lambda_{\max}$ there is a unique eigenvector $v^T = (v_1, \cdots v_m)$ so that

$$C v = \lambda_{\max} v$$

Where $v_i > 0$ for all $i$ and $\sum^m_{i=1} v_i = 1$. $v$ is the eigenvector for $C$. This positive, normalized (sum one), vector $v$ is the weights for C.

Then $w^T_k = (w_{1k}, \cdots, w_{nk})$ is the positive, normalized, eigenvector corresponding to $\lambda_{k\max}$ for each $A_k$, $1 \leqslant k \leqslant m$. The objective of hierarchical analysis is to rank the alternatives across all the criteria. Then ,assuming that the reciprocal $n\times n$ matrices $A_k$, $1 \leqslant k \leqslant m$, and a $m\times m$ matrix $C$ are reasonably consistent, the final ranking of the alternatives is determined by the vector $r^T = (r_1, \cdots, r_j, \cdots, r_n)$ where

$$r_j = \sum_{k=1}^{m} w_{jk} v_k \cdots\cdots(1)$$

The weight for candidate scheme $A'_j$ is $r_j$, $1 \leqslant j \leqslant n$.

### B. *Fuzzy Complementary Judgment Matrixes and Fuzzy Consistent Judge Matrixes*

*1) Fuzzy Scale(0.1-0.9)*

The original method in AHP elicit question using the 1-9 scale. The major shortcoming of conventional AHP methods is that the pairwise comparisons reciprocal judge matrix is not consistent easily. In this paper, fuzzy complementary judgment matrixes are adopted and can be converted to fuzzy consistent judge matrixes. So the fuzzy scale is adopted and it's value and means are showed as table II.

TABLE II. FUZZY COMPLEMENTARY JUDGMENT SCALE (0.1-0.9)

| $a_{ij}$ | Meaning of $a_{ij}$ | $a_{ji}$ |
|---|---|---|
| 0.5 | $A'_i$ is same important with $A'_j$ | 0.5 |
| 0.6 | $A'_i$ is little important than $A'_j$ | 0.4 |
| 0.7 | $A'_i$ is more important than $A'_j$ | 0.3 |
| 0.8 | $A'_i$ is important than $A'_j$ very much | 0.2 |
| 0.9 | $A'_i$ is absolutely important than $A'_j$ | 0.1 |

*2) Definitions of Fuzzy Complementary Judgment Matrix:*

a) In matrix $A = (a_{ij})_{n\times n}$, if $0 \leqslant a_{ij} \leqslant 1$, then the matrix $A$ is called as fuzzy one.

b) In fuzzy matrix $A = (a_{ij})_{n\times n}$, if $a_{ij} + a_{ji} = 1$, the matrix $A$ is called as fuzzy complementary one.

c) In fuzzy complementary matrix $A = (a_{ij})_{n\times n}$, for all $k$, if $a_{ij} = a_{ik} - a_{jk} + 0.5$, the matrix $A$ is called as fuzzy consistent one.

d) In fuzzy complementary matrix $A_l = (a^{(l)}_{ij})_{n\times n}$, $(l=1, 2, \cdots, s)$, define $\bar{a}_{ij} = \sum_{l=1}^{s} \lambda_l a^{(l)}_{ij}$, $\lambda_l > 0$, $\sum_{l=1}^{s} \lambda_l = 1$, then the matrix $A=(a_{ij})_{n\times n}$ is called as a compounding one of $A_l$ ($l$ =1 ,2 , $\cdots$ ,s). It can be written as $A=\lambda_1 A_1 \oplus \lambda_2 A_2 \oplus \cdots \oplus \lambda_S A_S$ 。

It is apparent that the matrix compounded by fuzzy consistent matrixes is still fuzzy consistent.

It is of actual meaning that the fuzzy consistent matrixes are compounded. Many fuzzy consistent matrixes from experts in a decision-making group can be compounded in a synthetically fuzzy consistent matrix. So it is easy to make decision in a group.

*C. Weight Vector and its Calculation of Fuzzy Complementary Judgment Matrix*

*1) Weight Vector and its General Formula for Decision-Making of Single One:*

For fuzzy complementary judgment matrix $A=(a_{ij})_{n\times n}$, the sum of the elements in each row is

$$r_i=\sum_{k=1}^{n}a_{ik}\quad,\quad i=1,2,\cdots,n \qquad (2)$$

and convert it as follow:

$$r_{ij}=\frac{r_i - r_j}{2(n-1)}+0.5 \qquad (3)$$

then $R=(r_{ij})_{n\times n}$ is a fuzzy consistent matrix. So the weight vector $\omega=(\omega_1,\omega_2,\cdots,\omega_n)^T$ is obtained from calculating and normalizing matrix R as follow:

$$\omega_i=\frac{\sum_{j=1}^{n}a_{ij}+\frac{n}{2}-1}{n(n-1)},\quad i=1,2,\cdots,n \qquad (4)$$

The (4) is the easy calculating formula for each weight.

*2) Weight Vector and its General Formulas for Group Decision-Making :*

In some cases, there are many experts participate in decision. So fuzzy complementary judgment matrix and its weight vector and general formulas can be used to the group decision. If there are $S$ experts to give $S$ fuzzy complementary judgment matrixes, $A_l=(a_{ij}^{(l)})_{n\times n}$, ($l$=1 ,2 ,$\cdots$ ,$s$), then sum of elements in line for matrix $A_l$ is

$$r_i^{(1)}=\sum_{k=1}^{n}a_{ik}^{(l)}\quad,\quad i=1,2,\cdots,n\ ;\ l=1,2,\cdots,s$$

and convert it as follow

$$r_{ij}^{(l)}=\frac{r_i^{(l)}-r_j^{(l)}}{2(n-1)}+0.5 \qquad l=1,2,\cdots,s \qquad (5)$$

then a fuzzy consistent matrixes $R_l=(r_{ij}^{(l)})_{n\times n}$, ($l$=1 ,2 ,$\cdots$ ,$s$) can be gotten. So the next fuzzy consistent matrixes can be compounded as follows:

$R'=(r_{ij}^{(l)})_{n\times n}$ , ($l$=1 ,2 ,$\cdots$ ,$s$)

among this, $r'_{ij}=\sum_{l=1}^{s}\lambda_l r_{ij}^{(l)}$ , $\lambda_l$>0, $\sum_{l=1}^{s}\lambda_l=1$

So the weight vector $\omega=(\omega_1,\omega_2,\cdots,\omega_n)^T$ is obtained from calculating and normalizing the compounded matrix $R'$ as follow.

$$\omega_i=\frac{\sum_{l=1}^{s}\sum_{j=1}^{n}\lambda_l\, a_{ij}^{(l)}+\frac{n}{2}-1}{n(n-1)},\quad i=1,2,\cdots,n \qquad (6)$$

So direct approach and computation of fuzzy eigenvector (weights vector) from a fuzzy, positive and complementary matrix is very easy. The final ranking weights can be obtained based on formula (4) or (6).

The proof of these formulas, theorems is omitted in this paper.

## IV. EXAMPLE OF LONG-MIDDLE TERM LOAD FORECAST FOR USING THE IMPROVED AHP

### *A. scheme and Their Forecast Results*

The soft method for load forecast using the improved AHP presented in this paper is used to forecast the power quantity and power load in the planning and designing the grid of hunan province in 2015. The original hard forecast methods and forecasting power quantity that will be combined are showed as table III.

TABLE III. THE ORIGINAL HARD FORECAST METHODS AND FORECASTING POWER QUANTITY (UNIT: 100GWH)

| Years / Forecast methods | 2000 Actual | 2005 Forecast | 2010 Forecast | 2015 Forecast |
|---|---|---|---|---|
| 1. Regression Analysis | 352 | 470 | 614 | 756 |
| 2. Elasticity Coefficient | 352 | 495 | 707 | 925 |
| 3. Production Value Per Unit Consumption | 352 | 486 | 633 | 712 |
| 4.grey GM(1,1) | 352 | 465 | 656 | 823 |
| 5. Neural Network | 352 | 491 | 693 | 889 |

### *B. Fuzzy Complementary Judgment Matrixes from Expert and Weight Vector*

Judgment matrixes of fuzzy complementary pairwise comparisons are written as follows separately. In table IV, each criterion is compared with others in pairwise for main goal. The right rank is the weight vector of each criterion that is calculated using eq. (4). If judgment matrixes are written by group decision-makers, the weight vector can be calculated using eq. (6).

TABLE IV. PAIRWISE COMPARISONS JUDGE MATRIXES BETWEEN CRITERIA $C'_k$ ($1\leqslant k\leqslant m$) FOR MAIN GOAL G

| G | $C'_1$ | $C'_2$ | $C'_3$ | $C'_4$ | Weights of each criterion |
|---|---|---|---|---|---|
| $C'_1$ | 0.5 | 0.6 | 0.7 | 0.8 | 0.3 |
| $C'_2$ | 0.4 | 0.5 | 0.3 | 0.4 | 0.2166667 |
| $C'_3$ | 0.3 | 0.7 | 0.5 | 0.5 | 0.25 |
| $C'_4$ | 0.2 | 0.6 | 0.5 | 0.5 | 0.2333333 |

In table V, each scheme is compared with others in pairwise for each criterion. The right rank in each table still is the weight vector of each scheme for each criterion. The weight vectors are calculated using eq. (4) or (6).

TABLE V. JUDGE MATRIX OF PAIRWISE COMPARISONS BETWEEN ISSUES $A'_1, \cdots, A'_n$ FOR EACH CRITERIA $C'_k$ ($1 \leq k \leq m$)

| $c'_1$ | $A'_1$ | $A'_2$ | $A'_3$ | $A'_4$ | $A'_5$ | Weights of each scheme for $c'_1$ |
|---|---|---|---|---|---|---|
| $A'_1$ | 0.5 | 0.5 | 0.6 | 0.4 | 0.4 | 0.195 |
| $A'_2$ | 0.5 | 0.5 | 0.6 | 0.3 | 0.4 | 0.19 |
| $A'_3$ | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.18 |
| $A'_4$ | 0.6 | 0.7 | 0.6 | 0.5 | 0.5 | 0.22 |
| $A'_5$ | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.215 |

| $c'_2$ | $A'_1$ | $A'_2$ | $A'_3$ | $A'_4$ | $A'_5$ | Weights of each scheme for $c'_2$ |
|---|---|---|---|---|---|---|
| $A'_1$ | 0.5 | 0.5 | 0.6 | 0.4 | 0.4 | 0.195 |
| $A'_2$ | 0.5 | 0.5 | 0.6 | 0.4 | 0.4 | 0.195 |
| $A'_3$ | 0.4 | 0.4 | 0.5 | 0.2 | 0.3 | 0.165 |
| $A'_4$ | 0.6 | 0.6 | 0.8 | 0.5 | 0.5 | 0.225 |
| $A'_5$ | 0.6 | 0.6 | 0.7 | 0.5 | 0.5 | 0.22 |

| $c'_3$ | $A'_1$ | $A'_2$ | $A'_3$ | $A'_4$ | $A'_5$ | Weights of each scheme for $c'_3$ |
|---|---|---|---|---|---|---|
| $A'_1$ | 0.5 | 0.5 | 0.6 | 0.2 | 0.3 | 0.18 |
| $A'_2$ | 0.5 | 0.5 | 0.6 | 0.3 | 0.3 | 0.185 |
| $A'_3$ | 0.4 | 0.4 | 0.5 | 0.2 | 0.1 | 0.155 |
| $A'_4$ | 0.8 | 0.7 | 0.8 | 0.5 | 0.6 | 0.245 |
| $A'_5$ | 0.7 | 0.7 | 0.9 | 0.4 | 0.5 | 0.235 |

| $c'_4$ | $A'_1$ | $A'_2$ | $A'_3$ | $A'_4$ | $A'_5$ | Weights of each scheme for $c'_4$ |
|---|---|---|---|---|---|---|
| $A'_1$ | 0.5 | 0.5 | 0.6 | 0.2 | 0.1 | 0.17 |
| $A'_2$ | 0.5 | 0.5 | 0.6 | 0.3 | 0.2 | 0.18 |
| $A'_3$ | 0.4 | 0.4 | 0.5 | 0.2 | 0.1 | 0.155 |
| $A'_4$ | 0.8 | 0.7 | 0.8 | 0.5 | 0.5 | 0.24 |
| $A'_5$ | 0.9 | 0.8 | 0.9 | 0.5 | 0.5 | 0.255 |

The weight vector of each scheme for main goal is calculated using the weight vectors in table 4-5 and eq. (1):

$$W = \begin{bmatrix} 0.195 & 0.195 & 0.18 & 0.17 \\ 0.19 & 0.195 & 0.185 & 0.18 \\ 0.18 & 0.165 & 0.155 & 0.155 \\ 0.22 & 0.225 & 0.245 & 0.24 \\ 0.215 & 0.22 & 0.235 & 0.255 \end{bmatrix} \begin{bmatrix} 0.3 \\ 0.21667 \\ 0.25 \\ 0.23333 \end{bmatrix}$$

$$= [0.1854 \quad 0.1875 \quad 0.1647 \quad 0.232 \quad 0.2304]^T$$

TABLE 6. FORECASTING RESULTS FOR POWER QUANTITY BY COMBINED FORECASTING METHOD OF THE IMPROVED AHP (UNIT: 100GWH)

| Scheme \ years | 2000 Actual | 2005 Forecast | 2010 Forecast | 2015 Forecast | Weights of each scheme |
|---|---|---|---|---|---|
| Regression Analysis | 352 | 470 | 614 | 756 | 0.1854 |
| Elasticity Coefficient | 352 | 495 | 707 | 925 | 0.1875 |
| Production Value Per Unit Consumption | 352 | 486 | 633 | 712 | 0.1647 |
| grey GM(1,1) | 352 | 465 | 656 | 823 | 0.232 |
| Neural Network | 352 | 491 | 693 | 889 | 0.2304 |
| Combined forecast results | 352 | 481.0 | 662.5 | 826.6 | |

Forecasting results for power load by combined forecasting method of the improved AHP can be obtained according to the same method and omitted in this paper.

## V. CONCLUSIONS

In this paper, the conception of soft method is first presented in electrical power load forecast. The combined forecasting problem is deal with multi-hierarchies and multi-factor decision-making analysis by composing qualitative analyses and quantitative calculation. A hierarchy analysis structure has been established.

Compared to current forecast method, the objective in the method proposed herein is not only the highest fitting accuracy as other hard methods, but also suitability of methods, concordance with future economic development and Believability of the forecast result. So satisfactory forecasting results can been recommended.

Fuzzy complementary judgment matrix adopted can be converted into fuzzy consistency. The eigenvector of matrix is used to be the combined weight vector. The vectors can be calculated briefly using the general formulation in single or group decision-making. The proposed solution algorithm is simple and the calculation formulation means clearly.

The practical example shows that this method can combine the advantage from many hard forecasting methods to one and combine experience and judgment from experts with calculation. So it is practical, accurate and efficient.

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