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Comprehensive Benefit Evaluation based on Interaction of Micro Grid and Distribution Network

Weiping Zhu[1], Xiaodong Yuan[2], Yunpeng Li[3]

[1.] *Jiangsu Electric Power Company, Nanjing, China, zwp_xjtu@163.com;*
[2.] *Jiangsu Electric Power Company, Nanjing, China, lannyyuan@hotmail.com;*
[3.] *Nantong Power Supply Company, Nantong, China,leeyunpeng@sina.com.*

Abstract

Interaction between micro grid and distribution network plays an important role in improving absorptive capacity of new energy, increasing utilization ratio of distribution network assets and promoting the safe, economy, environmental operation of power system. This paper mainly researched comprehensive benefit of different interaction models of micro grid and distribution network, firstly, classic interaction ways were studied, index system of comprehensive benefit was determined, then index weight was determined by analytic hierarchy process(AHP), at last, comprehensive benefit of different interaction models were analyzed according to fuzzy comprehensive evaluation, which could offer decision-making for interaction of micro grid and distribution network.

Key words*: Micro grid, distribution network , interaction , comprehensive benefit*

1. Introduction

Micro grid is a kind of independent and decentralized network, which is made up of solar power generation, wind power generation, hydropower, biomass generation, gas power generation, fuel cell and battery casually, including metering devices and controlling devices. It is independent of public grid or connected to the public grid intermittently. Distribution Network [1-3] is that whose voltage is 10kV～110kV, which has treelike, annular and reticulate connection modes, it is an important part in the power system facing the users. With the micro grid technology getting more and more mature, when the micro grid is connected to the distribution network, we hope it can improve electricity characteristic of distribution network, and reduce operating losses to realize efficient utilization of energy. As information technology develops, interaction between micro grid and distribution network becomes more and more close, not only exchange of power, but also exchange of information becomes more and more close [4-6].

Comprehensive benefit of different interaction models of micro grid and distribution network can provide scientific basis for investment decision of micro grid, which is essential to the development of micro technologies and development of distribution network building.

Domestic and foreign scholars have made some achievements about research on interaction between micro grid and distribution network, literature[7] established a gray comprehensive evaluation model of micro-grid and experimental verification was carried out; literature[8] evaluated impact micro grid had on the reliability of the distribution network by analyzing the improvement of reliability with the micro grid connected to distribution network; literature[9] analyzed the economic benefits smart micro grid technologies provided for the power system and the participation subject, it also built the evaluation model of principal component analysis with compulsory score. However, it is not perfect enough lacking of sound evaluation scheme about comprehensive benefit based on interaction of micro grid and distribution network.

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This paper took comprehensive benefit based on interaction of micro grid and distribution network as research object, firstly classic interaction ways were studied, index system of comprehensive benefit was determined, including economic benefit, social benefit and technical benefit. Then index weight was determined by analytic hierarchy process, at last, comprehensive benefit of different interaction models were analyzed according to fuzzy comprehensive evaluation.

2. Different Interaction Models

As for the power network, interaction between micro grid and distribution network[10-12] mainly reflects in three aspects: economic load distribution in normal situation; modulation of the load at the peak load when the load is too high; support of the main grid in emergency. Interaction between micro grid and distribution network is aimed at improving the ability of the grid to taking in new energy power, increasing utilization ratio of distribution network assets and bettering the safe, economy, environmental operation of power system. Different interaction models of micro grid and distribution network lie in the goals of coordinated cooperation.

Different interaction models of micro grid and distribution network are: firstly, interaction model based on economic goal; secondly, interaction model based on social goal; thirdly, interaction model based on technical goal.

The economic benefit of micro grid is the key point of attracting users and being promoted in the power system, economical operation of micro grid is an important method of realizing the economic benefit[13], interaction model based on economic goal emphatically considers the benefit of peak load shifting, the benefit of reducing fuel cost, the benefit of reducing investment cost of the grid, selling benefit of the grid, the benefit of delaying electric grid invests and the benefit of reducing spinning reserve in the grid.

Spreading use of micro grid plays a positive role in user experience, environmental improvement, social progress, interaction model based on social goal emphatically considers environmental benefit, promoting energy conversion efficiency and reducing electric cost expenditure of users.

Interaction between micro grid and distribution network can reduce the loss of operation of the grid, increase utilization ratio of distribution network assets and promote the safe, efficient, environmental operation of power system [14-16], interaction model based on technical goal emphatically considers the benefit of power supply reliability, the benefit of loss reduction and power quality.

3. Analytic Hierarchy Process

The steps of weight determination by analytic hierarchy process [17-18] are as below:

(1) Construct judgment matrix. A represents the goal, u_i, u_j(i，j=1，2…，n) are factors. u_{ij} represents the importance u_i means to u_j. Judgment matrix is made up of u_{ij}.

(2) Calculate importance ranking. Calculate the eigenvector ω corresponding to maximum characteristic root λ_{max} according to the judgment matrix.

$$P\omega = \lambda_{\max}\omega \tag{1}$$

P is the judgment matrix, after normalization the eigenvector ω is importance ranking of evaluation factors, which is also the weight distribution.

(3) Consistency check. Calculate the maximum characteristic root corresponding to every eigenvector. Then consistency check is carried out by using consistency index, random index and coincidence coefficient. The formula is as below:

$$CR = CI / RI \tag{2}$$

CR is coincidence coefficient of judgment matrix; CI is the general coincidence

coefficient. It is shown as below:

$$CI = (\lambda_{\max} - n) / (\mathrm{n}-1) \quad (3)$$

RI is the average random index of judgment matrix, the value of RI from first order to ninth order is shown in table1.

Table 1. The value of RI of Random Index

n	1	2	3	4	5
RI	0	0	0.50	0.90	1.12
n	6	7	8	9	
RI	1.24	1.32	1.41	1.45	

When CR is smaller than 0.1 or λ_{max} is equal to n, if CI is equal to zero, satisfaction of P is considered perfect, or the factors of P need to be adjusted.

4. Fuzzy Comprehensive Evaluation

Mathematical models of fuzzy comprehensive evaluation [19-20] can be divided into first grade model and multilevel model, in this paper multilevel model is adopted. The steps of mathematical models adopting multilevel model is shown as below:

(1) Clarify factor levels. Divide the organization of factors U into m subset.

$$U = \{u_1, u_2, \cdots u_i, \cdots u_m\} \quad (\mathrm{i} = 1, 2, \cdots, m)$$

u_i is the i-th factor in the first floor, which is determined by the n-th factor in the second floor:

$$U_i = \{u_{i1}, u_{i2}, \cdots, u_{ij}, \cdots u_{in}\} \quad (j = 1, 2, \cdots, n)$$

(2) Set up weight set. Provide corresponding weight value for every factor according to their importance value.

(3) Set up alternative set V. Alternative set is a collection of evaluation results valuator may give to evaluation object. Alternative set can be represented as below:

$$V = \{v_1, v_2, \cdots, v_p\}$$

In this paper five levels of "good, well, medium, poor, bad" are adopted.

(4) First grade model. Concerning that the factors in the first floor are determined by factors in the second floor, so single factor evaluation of every factor in the first floor should be results of multi factors evaluation in the second floor. Make single factor evaluation matrix in the second floor as R_i:

$$R_i = \begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i1p} \\ r_{i21} & r_{i22} & \cdots & r_{i2p} \\ \vdots & \vdots & & \vdots \\ r_{in1} & r_{in2} & \cdots & r_{inp} \end{bmatrix}$$

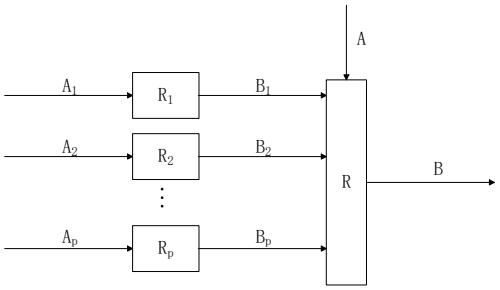
Row number of R_i is determined by the number of evaluation factors in r_{ij}. First grade fuzzy comprehensive evaluation set B_i can be got concerning weights:

$$\begin{aligned} B_i &= A_i \cdot \mathrm{R}_i \\ &= [a_{i1}, a_{i2}, \cdots, a_{in}] \cdot \begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i1p} \\ r_{i21} & r_{i22} & \cdots & r_{i2p} \\ \vdots & \vdots & & \vdots \\ r_{in1} & r_{in2} & \cdots & r_{inp} \end{bmatrix} \\ &= [b_{i1}, b_{i2}, \cdots, b_{ip}] \end{aligned} \quad (4)$$

In formula (4), " • " is fuzzy operator.

(5) Second grade fuzzy comprehensive evaluation. No matter how many floors there are, comprehensive evaluation results of the highest floor should be acquired. First-floor fuzzy comprehensive evaluation is just the results of the lowest floor. To calculate evaluation results of higher floor, second-floor fuzzy comprehensive evaluation should be carried out.

Composition of two floors can be sown in Picture 1:



Picture 1. Schematic Diagram of Second Grade Fuzzy Comprehensive Evaluation

Once given transformation matrix of the lowest floor and weight values matrix, comprehensive evaluation results of every floor as well as the final comprehensive evaluation results can be acquired.

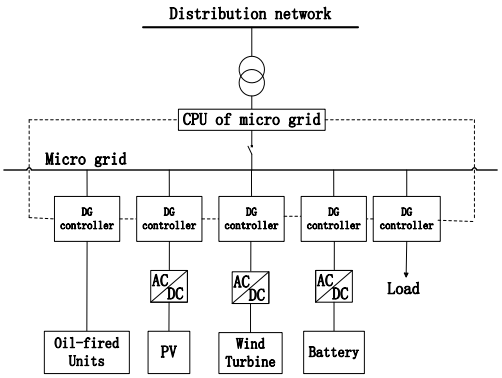
Fuzzy comprehensive evaluation model needs consider economic benefits, social benefits and technical benefits. Evaluation indexes of comprehensive evaluation are shown in Table 2. In view of benefit evaluation index of Interaction between micro grid and distribution network, firstly, index weight was determined by analytic hierarchy process, secondly, build up decision matrix by fuzzy comprehensive evaluation to carry out the evaluation, at last, comprehensive benefit of different interaction models were analyzed according to fuzzy comprehensive evaluation to determine the comprehensive benefit based on interaction of micro grid and distribution network, adopting maximum membership degree law.

Table 2. Comprehensive Benefit Evaluation Index System of the Grid

first grade indexes	second grade indexes
Economic benefits A	peak load shifting A1
	reduce fuel cost A2
	reduce investment costA3
	selling benefit of the grid A4
	delay electric grid invests A5
	reduce spinning reserve A6
Social benefits B	environmental benefit B1
	promote energy conversion efficiency B2
	reduce electric cost expenditure of users B3
Technical benefits C	power supply reliability C1
	loss reduction C2
	power quality C3

5. Example Analysis of Fuzzy Comprehensive Evaluation

Take a distribution network connected with micro grid for example, system wiring is shown in picture 2[21].



Picture 2. System Diagram of the Grid

5.1 Interaction Model based on Economic Goal

(1) Judgment matrix of the total evaluation index is as below:

$$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} A & B & C \end{array} \\ \begin{pmatrix} 1 & 2 & 5 \\ 1/2 & 1 & 2 \\ 1/5 & 1/2 & 1 \end{pmatrix} \end{array}$$

The methods of calculating weight vector and characteristic root are "sum-product method", "square root method" and "root method". Concerning that "sum-product method" is easy to calculate, so it is adopted in this paper.

$$A' = \begin{pmatrix} 0.5882 & 0.5714 & 0.625 \\ 0.2941 & 0.2857 & 0.25 \\ 0.1176 & 0.1429 & 10.125 \end{pmatrix}$$

Weight vector W= $(0.5949, 0.2766, 0.1285)^T$

The results are reliable with consistency Check.

(2) Judgment matrix is as below:

$$\begin{array}{c} \\ A1 \\ A2 \\ A3 \\ A4 \\ A5 \\ A6 \end{array} \begin{array}{c} \begin{array}{cccccc} A1 & A2 & A3 & A4 & A5 & A6 \end{array} \\ \begin{pmatrix} 1 & 2 & 3 & 3 & 4 & 5 \\ 1/2 & 1 & 2 & 2 & 3 & 3 \\ 1/3 & 1/2 & 1 & 1 & 1 & 2 \\ 1/3 & 1/2 & 1 & 1 & 1/2 & 1/2 \\ 1/4 & 1/3 & 1 & 2 & 1 & 1 \\ 1/5 & 1/3 & 1/2 & 2 & 1 & 1 \end{pmatrix} \end{array}$$

Weight vector can be calculated: W2=(A1,A2,A3,A4,A5,A6)T=(0.3589, 0.2182, 0.113, 0.1148, 0.1038, 0.0912)T。

With consistency, maximum characteristic root λ_{max}=6.3568.

(3) Judgment matrix of social benefits is as below:

$$\begin{array}{c} \\ B1 \\ B2 \\ B3 \end{array} \begin{array}{c} \begin{array}{ccc} B1 & B2 & B3 \end{array} \\ \begin{pmatrix} 1 & 3 & 5 \\ 1/3 & 1 & 2 \\ 1/5 & 1/2 & 1 \end{pmatrix} \end{array}$$

Weight vector can be calculated: W3=$(B1,B2,B3)^T$=$(0.648, 0.2299, 0.1222,)^T$; With consistency, maximum characteristic root λ_{max}=3.0037.

(4) Judgment matrix of technical benefits is as below:

$$\begin{array}{c} \\ C1 \\ C2 \\ C3 \end{array} \begin{array}{c} \begin{array}{ccc} C1 & C2 & C3 \end{array} \\ \begin{pmatrix} 1 & 2 & 4 \\ 1/2 & 1 & 5 \\ 1/4 & 1/5 & 1 \end{pmatrix} \end{array}$$

Weight vector can be calculated: $W3=(C1,C2,C3)^T=(0.532, 0.3661, 0.1018)^T$,; With consistency, maximum characteristic root $\lambda_{max}=3.0947$.

(5) Combination weight is designed as below:

Weight of first grade indexes can be calculated: W=(0.5949, 0.2766, 0.1285)T。

Combination weight of first grade indexes can be calculated:

$$W' = \begin{Bmatrix} 0.3589 & 0 & 0 \\ 0.2182 & 0 & 0 \\ 0.1130 & 0 & 0 \\ 0.1148 & 0 & 0 \\ 0.1038 & 0 & 0 \\ 0.0912 & 0 & 0 \\ 0 & 0.6480 & 0 \\ 0 & 0.2299 & 0 \\ 0 & 0.1222 & 0 \\ 0 & 0 & 0.5321 \\ 0 & 0 & 0.3661 \\ 0 & 0 & 0.1018 \end{Bmatrix} * W = \begin{Bmatrix} 0.2135 \\ 0.1298 \\ 0.0672 \\ 0.0683 \\ 0.0618 \\ 0.0542 \\ 0.1792 \\ 0.0636 \\ 0.0338 \\ 0.0684 \\ 0.0470 \\ 0.0131 \end{Bmatrix}$$

From the arithmetic expression above, specific evaluation results of comprehensive benefit based on interaction of micro grid and distribution network are shown in table 3.

Table 3. Evaluation Index System of Comprehensive Benefit

first grade indexes and weights		second grade indexes and weights	
Economic benefits A	0.5949	peak load shifting A1	0.214
		reduce fuel cost A2	0.130
		reduce investment costA3	0.067
		selling benefit of the grid A4	0.068
		delay electric grid invests A5	0.062
		reduce spinning reserve A6	0.054
Social benefits B	0.2766	environmental benefit B1	0.018
		promote energy conversion efficiency B2	0.063
		reduce electric cost expenditure of users B3	0.034
Technical benefits C	0.1258	power supply reliability C1	0.065
		loss reduction C2	0.047
		power quality C3	0.013

(6) The calculation of fuzzy comprehensive evaluation

Single factor evaluation results of economic benefits are shown in table 4:

Table 4. Single Factor Evaluation Results of Economic Benefits

factor set	comment set				
	good	well	medium	poor	bad
peak load shifting A1	0.65	0.22	0.129	0	0
reduce fuel cost A2	0.60	0.192	0.123	0.060	0.02

reduce investment cost A3	0.46	0.235	0.141	0.116	0.05
selling benefit of the grid A4	0.45	0.302	0.180	0.065	0
delay electric grid invests A5	0.80	0.144	0.015	0.043	0
reduce spinning reserve A6	0.77	0.116	0.056	0.038	0.02

Single factor evaluation matrix of economic benefits is as below:

$$R1=\begin{bmatrix} 0.651 & 0.220 & 0.129 & 0.000 & 0.000 \\ 0.604 & 0.192 & 0.123 & 0.060 & 0.021 \\ 0.458 & 0.235 & 0.141 & 0.116 & 0.050 \\ 0.453 & 0.302 & 0.180 & 0.065 & 0.000 \\ 0.798 & 0.144 & 0.015 & 0.043 & 0.000 \\ 0.769 & 0.116 & 0.056 & 0.038 & 0.021 \end{bmatrix}$$

Evaluation results vector of economic benefits:
$B1=(0.6222,0.1936,0.1164,0.0416,0.0121)^T$
Single factor evaluation results of social benefits are shown in Table 5:

Table 5. Single Factor Evaluation Results of Social Benefits

factor set	comment set				
	good	well	medium	poor	bad
Environmental benefit B1	0.521	0.312	0.089	0.078	0
Promote energy conversion efficiency B2	0.774	0.125	0.074	0.027	0
Reduce electric cost expenditure of users B3	0.499	0.345	0.130	0.026	0

Single factor evaluation matrix of social benefits is as below:

$$R2=\begin{bmatrix} 0.521 & 0.312 & 0.089 & 0.078 & 0.000 \\ 0.774 & 0.125 & 0.074 & 0.027 & 0.000 \\ 0.499 & 0.345 & 0.130 & 0.026 & 0.000 \end{bmatrix}$$

Evaluation results vector of social benefits:
$B2= (0.5765,0.2731,0.0906,0.0600,0.0000)^T$
Single factor evaluation results of technical benefits are shown in table 6:

Table 6. Single Factor Evaluation Results of Technical Benefits

factor set	comment set				
	good	well	medium	poor	bad
power supply reliability C1	0.598	0.302	0.090	0.006	0.004
loss reduction C2	0.769	0.162	0.014	0.053	0
power quality C3	0.479	0.316	0.096	0.089	0.02

Single factor evaluation matrix of technical benefits is as below:

$$R3=\begin{bmatrix} 0.598 & 0.302 & 0.090 & 0.006 & 0.004 \\ 0.769 & 0.162 & 0.014 & 0.053 & 0.000 \\ 0.479 & 0.316 & 0.096 & 0.089 & 0.020 \end{bmatrix}$$

Evaluation results vector of technical benefits:
B3=(0.6485,0.2522,0.0628,0.0316,0.0042)^T
Evaluation results of comprehensive benefit based on interaction of micro grid and distribution network are shown in table 7:

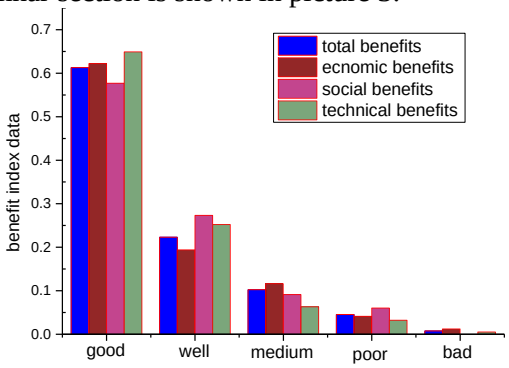
Table 7. Single Factor Evaluation Results of Fuzzy Evaluation

factor set	comment set				
	good	well	medium	poor	bad
Ecnomic benefits	0.622	0.194	0.116	0.041	0.012
Social benefits	0.577	0.273	0.091	0.060	0.000
Technical benefits	0.649	0.252	0.063	0.032	0.005

The total evaluation matrix R is made up of B1, B2, B3 as rows:

$$R=\begin{bmatrix} 0.6222 & 0.1936 & 0.1164 & 0.0416 & 0.0121 \\ 0.5765 & 0.2731 & 0.0906 & 0.0600 & 0.0000 \\ 0.6485 & 0.2522 & 0.0628 & 0.0316 & 0.0042 \end{bmatrix}$$

Comprehensive benefit vector based on interaction of micro grid and distribution network: B=(0.6129,0.2231,0.1024,0.0454,0.0077)^T
Corresponding columnar section is shown in picture 3:



Picture 3. Columnar Section of Comprehensive Benefit

In the final comprehensive evaluation results, membership degree belongs to “good” is 0.6129, the sum of membership degrees belongs to “good” and “well” is 0.836, according to maximum membership degree law, the answer is satisfactory, so, interaction of micro grid and distribution network has comprehensive significant benefits.

5.2 Interaction Model based on Social Goal

Judgment matrix of the total evaluation index is as below:

$$\begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} A & B & C \end{array} \\ \begin{pmatrix} 1 & 1/5 & 1/2 \\ 5 & 1 & 2 \\ 2 & 1/2 & 1 \end{pmatrix} \end{array}$$

Weight vector W=(0.1285, 0.5949, 0.2766)^T
The results are reliable with consistency Check.
Weight of first grade indexes can be calculated: W=(0.1285, 0.5949, 0.2766)^T.
Combination weight of first grade indexes can be calculated:

$$W' = \begin{Bmatrix} 0.3589 & 0 & 0 \\ 0.2182 & 0 & 0 \\ 0.1130 & 0 & 0 \\ 0.1148 & 0 & 0 \\ 0.1038 & 0 & 0 \\ 0.0912 & 0 & 0 \\ 0 & 0.6480 & 0 \\ 0 & 0.2299 & 0 \\ 0 & 0.1222 & 0 \\ 0 & 0 & 0.5321 \\ 0 & 0 & 0.3661 \\ 0 & 0 & 0.1018 \end{Bmatrix} * W = \begin{Bmatrix} 0.0461 \\ 0.0280 \\ 0.0145 \\ 0.0148 \\ 0.0133 \\ 0.0117 \\ 0.3855 \\ 0.1368 \\ 0.0727 \\ 0.1472 \\ 0.1013 \\ 0.0282 \end{Bmatrix}$$

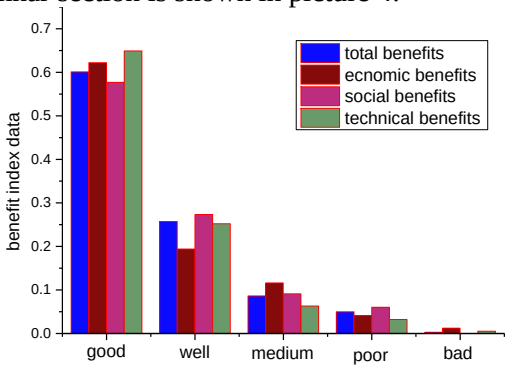
Specific evaluation results of comprehensive benefit based on interaction of micro grid and distribution network are shown in Table 8.

Table 8. Evaluation Index System of Comprehensive Benefit

first grade indexes and weights		second grade indexes and weights	
Economic benefits A	0.1285	peak load shifting A1	0.0461
		reduce fuel cost A2	0.0280
		reduce investment costA3	0.0145
		selling benefit of the grid A4	0.0148
		delay electric grid invests A5	0.0133
		reduce spinning reserve A6	0.0117
Social benefits B	0.5949	environmental benefit B1	0.3855
		promote energy conversion efficiency B2	0.1368
		reduce electric cost expenditure of users B3	0.0727
Technical benefits C	0.2766	power supply reliability C1	0.1472
		loss reduction C2	0.1013
		power quality C3	0.0282

Comprehensive benefit vector based on interaction of micro grid and distribution network: $B=(0.6011,0.2571,0.0862,0.0498,0.0027)^T$

Corresponding columnar section is shown in picture 4:



Picture 4. Columnar Section of Comprehensive Benefit

In the final comprehensive evaluation results, membership degree belongs to "good" is 0.6011, the sum of membership degrees belongs to "good" and "well" is 0.8582, according to maximum membership degree law, the answer is satisfactory, so, interaction of micro grid and distribution network has comprehensive significant benefits.

5.3 Interaction Model based on Technical Goal

Judgment matrix of the total evaluation index is as below:

$$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} A & B & C \end{array} \\ \begin{pmatrix} 1 & 1/3 & 1/5 \\ 3 & 1 & 1/2 \\ 5 & 2 & 1 \end{pmatrix} \end{array}$$

Weight vector $W=(0.1096,0.3091,0.5812)^T$

The results are reliable with consistency Check.

Weight of first grade indexes can be calculated: W=(0.1096,0.3091,0.5812)T.

Combination weight of first grade indexes can be calculated:

$$W' = \begin{Bmatrix} 0.3589 & 0 & 0 \\ 0.2182 & 0 & 0 \\ 0.1130 & 0 & 0 \\ 0.1148 & 0 & 0 \\ 0.1038 & 0 & 0 \\ 0.0912 & 0 & 0 \\ 0 & 0.6480 & 0 \\ 0 & 0.2299 & 0 \\ 0 & 0.1222 & 0 \\ 0 & 0 & 0.5321 \\ 0 & 0 & 0.3661 \\ 0 & 0 & 0.1018 \end{Bmatrix} * W = \begin{Bmatrix} 0.0393 \\ 0.0239 \\ 0.0124 \\ 0.0126 \\ 0.0114 \\ 0.0010 \\ 0.2003 \\ 0.0711 \\ 0.0378 \\ 0.3093 \\ 0.2128 \\ 0.0592 \end{Bmatrix}$$

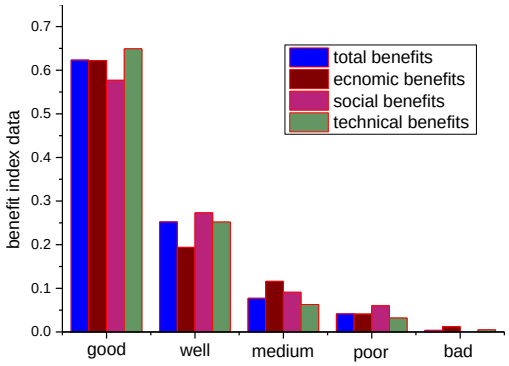
Specific evaluation results of comprehensive benefit based on interaction of micro grid and distribution network are shown in table 9.

Table 9. Evaluation Index System of Comprehensive Benefit

first grade indexes and weights		second grade indexes and weights	
Economic benefits A	0.1096	peak load shifting A1	0.0393
		reduce fuel cost A2	0.0239
		reduce investment costA3	0.0124
		selling benefit of the grid A4	0.0126
		delay electric grid invests A5	0.0114
		reduce spinning reserve A6	0.0010
Social benefits B	0.3091	environmental benefit B1	0.2003
		promote energy conversion efficiency B2	0.0711
		reduce electric cost expenditure of users B3	0.0378
Technical benefits C	0.5812	power supply reliability C1	0.3093
		loss reduction C2	0.2128
		power quality C3	0.0592

Comprehensive benefit vector based on interaction of micro grid and distribution network: $B=(0.6233,0.2522,0.0773,0.0415,0.0038)^T$

Corresponding columnar section is shown in Picture 5:



Picture 5. Columnar Section of Comprehensive Benefit

In the final comprehensive evaluation results, membership degree belongs to "good" is 0.6233, the sum of membership degrees belongs to "good" and "well" is 0.8755, according to maximum membership degree law, the answer is satisfactory, so, interaction of micro grid and distribution network has comprehensive significant benefits.

6. Solution

Interaction of micro grid and distribution network is the important link for china to build up forceful smart grid. In this paper, three types of interaction between micro grid and distribution network were determined, comprehensive benefits evaluation of which was carried. Firstly, index system of comprehensive benefit was determined, then index weight was determined by analytic hierarchy process, at last, comprehensive benefit of different interaction models were analyzed according to fuzzy comprehensive evaluation.

Example analysis shows that construction investment cost of Interaction of micro grid and distribution network is a little high, but in views of the whole society, think about improving reliability, energy saving, environmental protection and delaying electric grid invests, interaction of micro grid and distribution network produces much benefits. As for interaction model based on economic goal, interaction model based on social goal and interaction model based on technical goal, in the final comprehensive evaluation results, membership degree belongs to "good" is the biggest, what's more, membership degree belongs to "good" is bigger than 0.5 for all three interaction models, according to maximum membership degree law, the grid has significant comprehensive benefits. In addition, the analysis shows that membership degree belongs to "good" of interaction model based on technical goal is bigger than other two interaction models, which has the most significant comprehensive benefits.

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Authors

Weiping Zhu:(1983 —), male, doctor, majored in the research of post - fault analysis in power distribution systems; email: zwp_xjtu@163.com

Xiaodong Yuan: (1979 —), male , senior engineer , majored in the research of Power Performance and Power Quality; email: lnnayUyna@hotmail.eom

Yunpeng Li: (1978 —),male, senior engineer , majored in the research of information management and technical work of power System Automation ; email: leeyunpeng@sina.com

