2008 American Control Conference
Westin Seattle Hotel, Seattle, Washington, USA
June 11-13, 2008

Multi-objective Model of Power Terminate Plan in Multi-zone Peak Load Shifting Control

Yang Li, Jia Liu, Liqun Gao, and Zhi Kong

***Abstract*— A novel multi-objective optimal short-term power terminate planning in a multi-zone power system was presented. Both dissatisfaction degree of dwellers and economic loss were considered in this model. At first, the dissatisfaction degree function of residents was constructed; secondly, each single-objective deterministic model was solved so that its objective value was got along with the results of unit commitment and power dispatch, then the power terminate distribution strategy of peak load shifting control was analyzed and the power terminate time of peak load shifting control was selected. Finally, the multi-objective programming problem was reformulated into weighted nonlinear single objective programming problem so as to get the optimal power terminate distribution of each zone. The numerical results demonstrate that the scheme obtained from the multi-objective model can meet functions better than that obtained from the single-objective deterministic model with slight variation in the every single-objective. This method of decision making is significant for sustainable development strategy and the multi-factor justice of power distribution for peak load shifting control planning**.

I. INTRODUCTION

With the rapid development of economics, the global nature of energy crisis began large-scale outbreak [1-3], in particular, many developing countries facing energy shortages. In China most provinces in eastern and central zones appeared the phenomena of power scarcity since 2003[4]. To alleviate the intense situation of power scarcity, State Grid Company had increased extensively generating capacity. However, the electric power consumption is far more than power quantity provided by having developed foundation buildings. So these results in increasing power scarcity in every zone of China. Although peak load shifting had been employed by using economic and political methods to alleviate this predicament [5], it is necessary to limit the quantity of power consumed in sectional zones at peak time-interval considering the safety of power line. For some developed zones in the south of China, power-off protection is practiced even in two third of whole working days [6]. It is very practical and meaningful to adjust the quantity of power limiting scientifically and reasonably in each zone according to the rules of power limiting and safety for the purpose of obtaining the combination of the most power line security and the least economic loss. But the researches of the power terminate distribution in peak load shifting control are at the initial stage, and the international research papers of this area are almost blank.

On decision of peak load shifting control distribution, not only limiting power criterion, power line situation, engineering programming and benefit but also the problems of zone population, society, economics, ecological condition are considered[7-9]. In the power limiting distribution zone of peak load shifting control, except for superior class of power supply, i.e. some departments which are not admitted to be powered off in common condition such as hospital, underground mine, transmission, aviation, railway etc., the zone is classified two types: industrial zone and residential zone. Industrial zone power-off may bring economic losses which are considered to be proportional linearly to power-off time span. Resident zone power-off may result in dissatisfaction of different degree, which is about proportional linearly to power-off time span and connected with power-off time interval, power-off time zone and air temperature. Therefore, power limiting distribution belongs to nonlinear multi-objective decision problem [10-15].

In the remainder of the paper, we begin with the modeling of residents' dissatisfaction degree, and then offer the multi-objective model of the power terminate distribution in multi-zone peak load shifting control. Subsequently, by the analysis of the power terminate distribution strategy and the selection of the power terminate time of peak load shifting control, we get the optimal power terminate distribution of each zone. Finally, we conclude the paper with a discussion of the results and future work.

II. MODELING OF RESIDENTS' DISSATISFACTION DEGREE

Influence factors of residents' dissatisfaction degree, which origins in controlling process of limited power capacity distribution of peak load shifting in industrial and resident areas, include each power- off time span, power-off time interval and temperature at present. In order to decrease the model solving difficulty which is attributed to rather complicated dissatisfaction function and make decision rapidly and scientifically, explicit function of dissatisfaction degree is constructed from the view of main dissatisfaction factors.

It has been found that the relationship between resident

This work is supported by the Specialized Research Fund for the Doctoral Program of Higher Education under Grant 20020145007.

Yang Li is with Faculty of Information Science and Engineering, Northeastern University, 110004, Shenyang, Liaoning, P.R. of China. (e-mail: holy_blood@163.com)

Jia Liu is with Faculty of Information Science and Engineering, Northeastern University, 110004, Shenyang, Liaoning, P.R. of China.

Liqun Gao is with Faculty of Information Science and Engineering, Northeastern University, 110004, Shenyang, Liaoning, P.R. of China. (e-mail: gaoliqun2064@sina.com.cn)

Zhi Kong is with Faculty of Information Science and Engineering, Northeastern University, 110004, Shenyang, Liaoning, P.R. of China.

978-1-4244-2079-7/08/$25.00 ©2008 AACC.

dissatisfaction degree and power-off time span can be described by S function under constant temperature condition. With the power-off time span increases, the resident' dissatisfaction degree increases gradually. In residents' noncentralized power consumption span, residents' dissatisfaction degree increases slowly with the increasing power-off time span, while in the centralized power consumption span, residents' dissatisfaction degree increases sharply with the increasing power-off time span. The centralized power consumption span and noncentralized power consumption span are listed as following:

Centralized power consumption span: 6:00—8:00; 18:00—22:00

Noncentralized power consumption span: 00:00—6:00; 8:00—18:00; 22:00—00:00

Furthermore, average temperature in a day can also influence the residents' dissatisfaction degree during power-off time span. For example, if the average temperature in the summer is lower than 28, the temperature has little change on the residents' dissatisfaction degree. However, if the temperature is higher than 28, the residents' dissatisfaction degree will increase significantly with the increasing power-off time span.

According to the discussion above, the residents' dissatisfaction degree, *D(t,T)*, as a function of power-off in the summer is determined by

$$D(t,T)=\begin{cases}1\Big/\left(1+a\times e^{-b(\frac{T-28}{28})(t-c)}\right) & T>28^{\circ}C\\ 1\big/\left(1+a\times e^{-b(t-c)}\right) & T\le 28^{\circ}C\end{cases} \quad (1)$$

where, *a*, *b* and *c* are constants, which are gained by fitting, *t* is the power-off length, and *T* is the average temperature in a day. In the current model, the average temperature can be set according measurement results,a constant w is given by

$$\omega=\begin{cases}\dfrac{T-28}{28} & T>28^{\circ}C\\ 1 & T\le 28^{\circ}C\end{cases} \quad (2)$$

In both of the residents' noncentralized power consumption span and centralized power consumption span, according to four cases of power-off time span, the residents' dissatisfaction degree of power-off can be expressed as four different formulas:

1) Both the start time and end time of power-off are in the noncentralized power consumption span,

$$D(t)=1\big/\left(1+a_1\times e^{-\omega b_1(t-c_1)}\right) \quad (3)$$

2) Both the start time and end time of power-off are in the centralized power consumption span,

$$D(t)=1\big/\left(1+a_2\times e^{-\omega b_2(t-c_2)}\right) \quad (4)$$

3) The start time of power-off is in the noncentralized power consumption span, while the end time of power-off is in the centralized power consumption span,

$$D(t)=\begin{cases}1\big/\left(1+a_1\times e^{-\omega b_1(t-c_1)}\right) & t_0\le t\le t_1\\ 1\big/\left(1+a_2\times e^{-\omega b_2(t-c_2)}\right) & t_1\le t\le t_2\end{cases} \quad (5)$$

where $\left[t_0,t_1\right]$ is noncentralized power consumption span, $\left[t_1,t_2\right]$ is centralized power consumption span.

4) The start time of power-off is in the centralized power consumption span, while the end time of power-off is in the noncentralized power consumption span,

$$D(t)=\begin{cases}1\big/\left(1+a_2\times e^{-\omega b_2(t-c_2)}\right) & t_0\le t\le t_1\\ 1\big/\left(1+a_1\times e^{-\omega b_1(t-c_1)}\right) & t_1\le t\le t_2\end{cases} \quad (6)$$

where $\left[t_0,t_1\right]$ is centralized power consumption span, $\left[t_1,t_2\right]$ is noncentralized power consumption span..

III. Multi-objective Peak Load Shifting Control Model of Multi-zone Limiting Power

The model based on minimal economic losses and minimal residents' dissatisfaction value of power-off is:

$$\min f_1=\min\sum_{t=1}^{T}\sum_{i=1}^{m}L_i(t)\cdot I_{t,i} \quad (7)$$

$$\min f_2=\min\sum_{t=1}^{T}\sum_{i=1}^{m}\lambda_i D_i(t)\cdot I_{t,i} \quad (8)$$

$$\text{s.t. } P_{i\min}\le P_{i,t}\le P_{i\max} \quad (9)$$

$$\sum_{i=1}^{m}P_{i,t}J_{t,j}\le P_D(1+R_U) \quad (10)$$

$$(V_{t,i}^{on}-T_i^{\min-on})\ge 0 \quad (11)$$

$$(V_{t,i}^{off}-T_i^{\min-off})\ge 0 \quad (12)$$

$$(T_i^{\max-off}-V_{t,i}^{off})\ge 0 \quad (13)$$

Object function (7) regards companies' minimal economic losses in peak load shifting control of power-off as object. Where $L_i(t)$ is the *ith* zones' economic losses of power-off *t* time, which is approximated linear function to the power-off time *t*; *T* is trading planning periodic time. In this paper, *T* is 24 time-interval. $I_{t,I}$ is the state of *ith* consumption zone. If $I_{t,i}$=1, it means *ith* zone is powered off at *t* time, while if $I_{t,i}$=0, it means regular operation of *ith* zone at *t* time (non power-off); *m* is the number of power zones in peak load shifting control.

Object function (8) regards residents' minimal dissatisfaction value in peak load shifting control of power-off as object. Where $D_i(t)$ is the *ith* zone's dissatisfaction degree at *t* time power-off. Concrete constitution of dissatisfaction degree function can be seen in section 2, λ_i is the *ith* zone's total population. $D_i(t)$ multiply λ_i denotes dissatisfaction value.

Constraint (9) is the zone's restriction of power consumption, P_{imin}, P_{imax} are respectively minimal power restriction and maximal power restriction of *ith* zone.

Constraint (10) is the safety constraint of total load of consumption power system. Where $J_{t,i}$ is the *ith* zones' state. If $I_{t,i}$=0, it means *ith* zone is powered off at *t* time, while if $I_{t,i}$=1, it means regular operation of *ith* branch at *t* time (non power-off), that is $I_{t,i}+J_{t,i}$=1; P_D is the total predicted load [16-19] of consumption power system, R_U is the positive percentage reserve.

Constraint (11) is minimal power supply time constraint of each zone. $V^{on}_{t,i}$ is sustained time of power supply at time interval *t* of the *ith* zone; T^{min-on}_{t} is minimal power supply time.

Constraint (12) and (13) are respectively minimal power-off time and maximum power-off time constraint of each zone. $V^{off}_{t,i}$ is sustained time of power-off at time interval t for the *ith* zone; $T^{min\text{-}off}_t$ and $T^{max\text{-}off}_t$ are respectively minimal power-off time and maximum power-off time.

IV. The Strategy Of Power Limiting Distribution Based on Peak Load Shifting Control

Total load of power must meet the safety condition according to constraint (10) in preceding section. In practical operation of power line, the principal factor is power system safety. So if the sum of predicted power load in all zones exceeds the maximal safe load (see (14)), in order to protect power system operation regularly, it must be some zones to power-off.

$$\sum_{i=1}^{m} P_{i,t} > P_D(1+R_U) \tag{14}$$

To simplify the problem we choose m power supply zone, and regard industrial zones and residential zones as an integer in each zone. According to the degree of total predicted load exceeding maximal power load, the problem can be classified as four cases:

1) The sum of predicted power load which exceeds the maximal safe load is more than the relative larger value among each zone (see (15)). It is that, in such time interval if only powering off only one zone (suppose power load in this zone is larger than that in each other zone), however the safety load condition can't be met in this power system. In order to protect the power system safety, in this time interval, there must two zones to be powered-off at least.

$$\sum_{i=1}^{m} P_{i,t} - P_D(1+R_U) > \max\{P_{i,t}\} \tag{15}$$

In practice the difference between power generation and power consumption can't reach such wide gap, so the case may regard as boundary.

2) The sum of predicted power load which exceeds the maximal safe load is more than the relative minimum value among each zone, but less than the relative maximal value among each zone (see (16)). It is that, in such time interval if only powering off one zone (suppose power load in this zone is less than that in each other zone), however the safety load condition can't be met in this power system. In order to protect the power system safety, in this time interval the zones which load capacity is more than the least one need to be powered off.

$$\begin{cases} \sum_{i=1}^{m} P_{i,t} - P_D(1+R_U) > \min\{P_{i,t}\} \\ \sum_{i=1}^{m} P_{i,t} - P_D(1+R_U) > \max\{P_{i,t}\} \end{cases} \tag{16}$$

3) The sum of predicted power load which exceeds the maximal safe load is less than the relative minimum value among each zone, (see (17)). It is that powering off any one zone can meet the safety load condition in power system. In order to protect the power system safety, in this time interval any zone may be powered off.

$$0 < \sum_{i=1}^{m} P_{i,t} - P_D(1+R_U) < \min\{P_{i,t}\} \tag{17}$$

In the practice this case is common. For this case we research the limiting power decision of peak load shifting control and give attention to economic losses and social benefits (the former cases can't get the decision of power-off).

4) The sum of predicted power load does not exceed the maximal safe load (see (18)). In this case safety load condition can be met which needn't power-off.

$$\sum_{i=1}^{m} P_{Fi,t} + \sum_{i=1}^{n} P_{Pi,t} - P_D(1+R_U) < 0 \tag{18}$$

V. Time Interval Selection of Power-off Distribution in Peak Load Shifting Control

How to distribute the proportion of each zone reasonably is the key of choosing optimizing strategies of peak load shifting control in constant power-off time span. Obviously in distribution of peak load shifting both enterprise economic losses and residential dissatisfaction value are the two focus factors to be considered. In the condition of local power load exceeding guarantee load, if ensuring minimal residential dissatisfaction value, we should take possible measures as far as to power off the zones which population are less than the others; while if ensuring minimal enterprise economic losses, we should take possible measures as far as to power off the zones which economic losses are less than the others in peak load shifting control.

The residential dissatisfaction value related to whether the power-off time is in the residential concentrated consumption time span besides population and power-off length. So avoiding power-off in the residential concentrated consumption time span is rational, which can decrease the residential dissatisfaction value effectively. If at the situation we must powered off at the zones that residential concentrated consumption time span, we should take the measures to rotate all zones, which can also decrease the all dissatisfaction value.

When adjust the distribution power, we need pay attention to some constrains of minimal power-on time, minimal power-off time and maximum power-off time. Do not random switch the state of power-on and power-off in short time.

Before distribution power-off of peak load shifting control, firstly we need calculate each time-interval total predicted load of each zones and the summation of the whole system. Then comparing total predicted power load to maximal safety load of power line in each time-interval, then we need choose the power-off decision according to four cases in the former section.

Finally, we can list some power-off schemes accord with the power terminating optimal strategy based on the conditions of predicted power load. Then we choose the optimal scheme that has least enterprise economic losses and residential dissatisfaction value. Because of the emphasis point of these two factors are different, we can adjust weights in accordance with the formula (19) and ultimately achieve optimal power-off strategy of the power system we research.

$$W = \omega_1 f_1 + \omega_2 f_2 \quad (\omega_1 + \omega_2 = 1) \tag{19}$$

When ω_1=1, ω_2=0, It is aimed to select the scheme of least power-off economic losses take no account of residential dissatisfaction value;

When ω_1=0, ω_2=1, It is aimed to select the scheme of least residential dissatisfaction value take no account of power-off economic losses;

When ω_1=0.5, ω_2=0.5, It is aimed to select the scheme of least W which take account of power-off economic losses and residential dissatisfaction value as the same weight.

VI. EXAMPLE ANALYSIS

We choose Shenyang power system in Province Liaoning of China, which includes six power zones. The unit of load is MW, $T^{min\text{-}on}_t$=12 hour, $T^{min\text{-}off}_t$ =1 hour, $T^{max\text{-}off}_t$=2 hour, P_D=202MW, R_U=5%. The intraday temperature is T=30°C.

The curve of figure 6 and figure 7 are respectively of each zone's and summation's time-interval predicted power load at August 5, 2006. Upper limit of guarantee load is $P_{max}=P_D(1+R_U)$=212.1 MW.

Figure 7 shows: after reaching the valley value of the predicted load in 3:00-5:00, the predicted curve value increase along with the temperature, and the peak value be reached at 20:00-21:00. The summation predicted load exceeds upper limit of guarantee load at 9:00-11:00 and 18:00-22:00. In the two time-intervals and six hours of total time, to ensure power line safety we need make power-off decisions on some of the six zones.

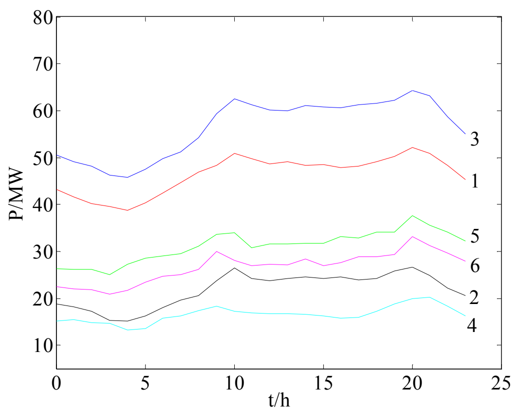

Fig. 6 The curve of each time-interval of predicted power load in each six zones at August 5, 2006

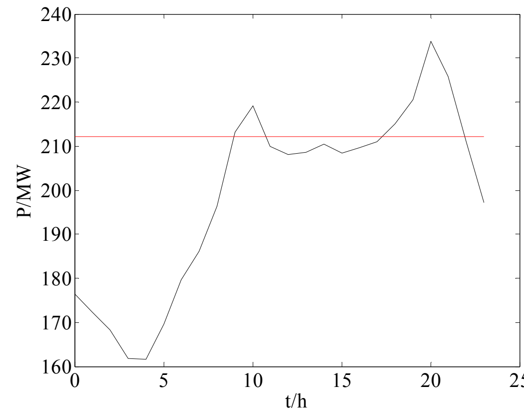

Fig. 7 The curve of each time-interval load of summation predicted power load at August 5, 2006

The sum of total predicted power load in 9:00-10:00 is 213.2MW, which exceeds the maximal safe load 1.1MW. It can meet the power system safety if anyone of the six zones is powered-off.

The sum of total predicted power load in 10:00-11:00 is 219.2MW, which exceeds the maximal safe load 7.1MW. It can meet the power system safety if anyone of the six zones is powered-off.

The sum of total predicted power load in 18:00-19:00 is 215.1MW, which exceeds the maximal safe load 4.0MW. It can meet the power system safety if anyone of the six zones is powered-off.

The sum of total predicted power load in 19:00-20:00 is 220.5MW, which exceeds the maximal safe load 8.4MW. It can meet the power system safety if anyone of the six zones is powered-off.

The sum of total predicted power load in 20:00-21:00 is 233.8MW, which exceeds the maximal safe load 21.7MW. It can meet the power system safety if anyone of the other 5 zones except the zone 4(the predicted power load of zone 4 is 19.9 <21.7) is powered-off.

The sum of total predicted power load in 21:00-22:00 is 225.8MW, which exceeds the maximal safe load 13.7MW. It can meet the power system safety if anyone of the six zones is powered-off.

Economic losses of *ith* zone assume approximate linear function and set L_i dollars per hour.

$$L(t) = L_i t \,(\$)$$

The residential dissatisfaction degree function is:

$$D(t) = \begin{cases} \dfrac{1}{(1+7e^{-2(t-1)})} & \textit{(where t is in the residential nonconcentrated time-interval)} \\ \dfrac{1}{(1+3e^{-2(t-1)})} & \textit{(where t is in the residential concentrated time-interval)} \end{cases}$$

The population of ith zone is λ_i and the economic losses per hour of ith zone is L_i , just like table I.

TABLE I
THE POPULATION AND THE ECONOMIC LOSSES PER HOUR OF EACH ZONE

Zone	Population(10^4)	Economic losses(10^4\$)
Zone 1	56.4	28.7
Zone 2	23.1	8.2
Zone 3	89.1	34.6
Zone 4	10.6	9.5
Zone 5	26.2	10.4
Zone 6	33.5	9.1

Table I shows that the regional population and economic losses of zones 1 and 3 are far more than the other four zones' average level. Therefore in order to optimize the overall power system, it must avoid these two zones to be powered-off. According to the economic loss, the priority of power-off is 2-6-4-5; According to the district population, the priority of power-off is 4-2-5-6.

We can find the entire feasible power-off scheme (listed in Table II) based on the restriction of power system ($T^{min\text{-}on}_t$=12(hours), $T^{min\text{-}off}_t$ =1(hour), $T^{max\text{-}off}_t$=2(hours), and power-off in zone 4 can not meet power system safety during 20:00-21:00).

In some special fixed time interval (example 9:00-11:00 or 18:00-22:00), the economic losses and residents' dissatisfaction degree are have relationship only on time length but not the power-off order. So, there are some different options for the power-off schemes, which their economic losses and residents' dissatisfaction degree are the same value. For example, in accordance with the six time-domains in the order we choose power-off program 2-2-5-5-6-6, with another power-off program 2-2-6-6-5-5. These two programs are exactly the same. Furthermore, such as 2-5-4-4-6-6 and 5-2-6-6-4-4; or 4-4-6-5-5-2, 4-4-5-5-2-6, 4-4-2-5-5-6, 4-4-5-5-6-2, 4-4-2-6-5-5 and 4-4-6-2-5-5. These eight power-off schemes are exactly the same effect. Thereby when we prepared to choose different power-off programs, we should classify the same effect choice as a type of options for analysis.

We select the optimal power-off program according the formulation (19). Here we let ω_1=0.5, ω_2=0.5, It is aimed to select the scheme of least W which take account of power-off economic losses and residential dissatisfaction value as the same weight. Suppose W as the optimization power-off scheme, let W=W*(as shown in Table II).

TABLE II
THE LIST OF FEASIBLE POWER-OFF SCHEME AS WELL AS THE ECONOMIC LOSSES AND THE RESIDENTIAL DISSATISFACTION VALUE OF POWER SYSTEM

Power-off zone / Scheme	9	10	18	19	20	21	*L*	*D*	*W**
1	2	2	4	4	5	5	56.2	38.0	47.1
2	2	2	5	5	6	6	55.4	54.3	54.9
3	2	2	4	4	6	6	53.6	43.2	48.4
4	2	2	4	5	6	6	54.5	44.9	49.7
5	2	2	4	4	5	6	54.9	34.3	44.6
6	2	2	4	5	5	6	55.8	41.5	48.7
7	2	4	5	5	6	6	56.7	46.7	51.7
8	2	5	4	4	6	6	55.8	37.5	46.7
9	2	6	4	4	5	5	57.1	33.2	45.2
10	4	4	2	2	5	5	56.2	40.5	48.4
11	4	4	2	2	6	6	53.6	45.7	49.7
12	4	4	5	5	6	6	58.0	47.9	53.0
13	4	4	2	5	6	6	55.8	41.6	48.7
14	4	4	2	2	5	6	54.9	36.8	45.9
15	4	4	2	5	5	6	57.1	38.2	47.7
16	4	5	2	2	6	6	54.5	44.8	49.7
17	4	6	2	2	5	5	55.8	40.6	48.2
18	5	5	2	2	6	6	55.4	53.7	54.5
19	5	5	4	4	2	2	56.2	37.4	45.5
20	5	5	4	4	6	6	58.0	44.8	51.4
21	5	5	2	4	6	6	56.7	45.7	51.2
22	5	5	4	4	2	6	57.1	35.1	46.1
23	5	5	2	2	6	4	55.8	40.9	48.4
24	5	6	4	4	2	2	54.9	31.4	43.2
25	6	6	4	4	2	2	53.6	41.2	47.4
26	6	6	4	4	5	5	58.0	43.4	50.7
27	6	6	2	2	5	5	55.4	52.3	53.9
28	6	6	2	4	5	5	56.7	44.3	50.5
29	6	6	4	4	2	5	55.8	37.1	46.5
30	6	6	2	2	5	4	54.5	42.8	48.7

From the Table II we can see that if only considering the least economic losses when powered-off, the third program, eleventh program and twenty-fifth program are all meet the requirement, among these three programs the residents' dissatisfaction value of the twenty-fifth program has the smallest value.

If only considering the least residents' dissatisfaction value, the twenty-fourth program is the optimal power-off scheme.

If considering both the residents' dissatisfaction value and economic losses are least, the twenty-fourth program is also the optimal power-off scheme.

The former analysis has not powered-off in zone 1 and region 3. Assuming these two zones to take into account the power-off strategy, in accordance with the sequence of 1-2-3-4-5-6 power-off program, it can calculate that L=100.5, D=49.8, the residents' dissatisfaction value and economic losses are all more than the twenty-fourth power-off program we got former. Thus it is verified to be the correct assumption that avoiding these two zones to be powered-off.

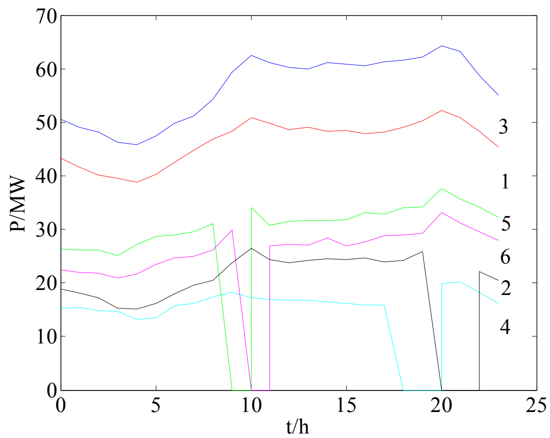

Fig. 8 The curve of each time-interval of predicted power load in each six zones at August 5, 2006 after adopting the twenty-fourth power-off program

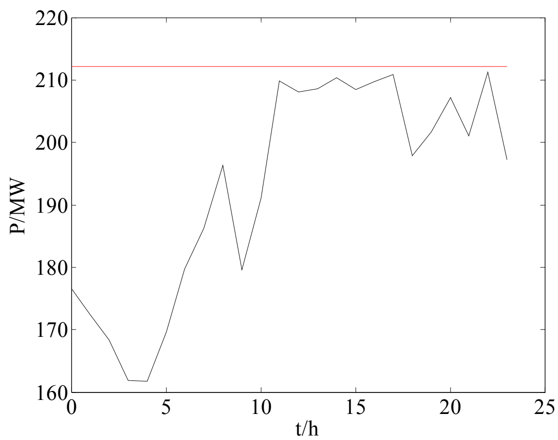

Fig. 9 The curve of each time-interval load of summation predicted power load at August 5, 2006 after adopting the twenty-fourth power-off program

The curves of figure 8 and figure 9 are respectively of each zone's and summation's time-interval predicted power load at August 5, 2006 after adopting the twenty-fourth power-off program.

VII. Conclusion

A new model of short term power-off is presented based on peak load shifting control in the case of predicted power load exceeding the maximal safety load of power system, which consider residential dissatisfaction value and economic losses of power-off at same time. The new comprehensive model can be better to dispose the multi-object multi-zone optimal problem of power-off distribution using peak load shifting control.

Simulation result shows that when considering multi-factors power-off distribution, we should possibly avoid power-off at residential concentrated consumption power and rotate each zone to power-off under the restriction of minimal power-on time, minimal power-off time and maximum power-off time, which can also decrease the residential dissatisfaction value and reach the optimal result lastly.

In this paper we regard industrial zones and residential zones as one zone when analyzing the power-off schemas. In practical power-off distribution, we should consider the industrial zones and residential zones as different. Take account of the difference of load capacity and economic losses of power-off in multi-zone, the construction of multi-object and multi-zone optimal fuzzy planning model is the succeeding work.

References

[1] Parkins WE, "Energy - Fusion power: Will it ever come? " *Science*, pp. 1380, Mar, 2006.

[2] Reiss S, "What energy crisis? " *Technology Review*, vol. 2, pp.19, Feb 2005.

[3] Anon, "Power crisis, energy blob" *Oil & Gas Journal*, vol. 33, pp. 23 Aug, 2003.

[4] S.L. Deng, "Why the power so scarcity?" China Today, pp. 55-58, Feb, 2004.

[5] R.W. Xu, "Incentive policy and implement mechanism research on peak load period," *Power Demand Side Management*, vol. 3, pp. 16–19, June 2004.

[6] S.Liu, X.J.Qiu, "Take different measures to relieve tense power contradiction," *Power Demand Side Management*, vol. 7, pp. 53–54, Jan, 2004.

[7] Shamsuddin Ahmed,Seasonal "Models of peak electric load demand," *Technological Forecasting and Social Change*. vol. 72, pp. 609–622, May, 2005.

[8] M.R.G. Al-Shakrchi, M.M. Ghulaim, "Short term load forecasting for Baghdad electricity region," *Electr. Mach. Power Syst*, vol. 28, pp. 355–371, Mar, 2000.

[9] T. Senjyu, H. Sakihara, Y. Tamaki, K. Uezato, "Next day peak load forecasting using neural network with adaptive learning algorithm based on similarity," *Electr. Mach. Power Syst*, vol. 28, pp. 613–624, Jun, 2000.

[10] H.W.Tang, X.Z.Qin, *Optimization method,* (Book style), Dalian, Dalianligong Press, 1994, pp.98-122.

[11] Delgado M, Herrera F, Herrera Viedma E, "Combining numerical and linguistic information in group decision making," *Information Sciences*, vol. 10, pp. 177-194, July, 1998.

[12] Chiclana F, Herrera F, Herrera Viedma E.,"Integrating three representation models in fuzzy multipurpose decision making based on fuzzy preference relations," *Fuzzy Sets and Systems*, vol. 9, pp. 33-48, July, 1998.

[13] Noel Bryson, Ayodele Mobolurin, "An action learning evaluation procedure for multiple criteria decision making problems," *European Journal of Operational Research*, vol. 6, pp. 379-386, Sep, 1999.

[14] Hawng CL, Yoon K, *Multiple attribute decision making*, (Book style), SpringerVerlag, Berlin, Heidelberg New York, 1981, pp.1-107.

[15] J. Ma, Z.P. Fan, L.H.Huang, "A subjective and objective integrated approach to determine attribute weights," *European Journal of Operational Research*, vol. 12, pp. 397-404, Jan, 1999.

[16] Willis H L. *Spatial Electric Load Forecasting* (Book style), New YorkMarcelDekker, 1996, pp.15-33.

[17] Chow M Y, Tram H. "Methodology of urban re-development considerations in spatial load forecasting". *IEEE Trans. on Power Systems*, vol. 12, pp.996-1001. Feb,1997,

[18] Mo-yuen Chow, Jinxiang Zhu, Hahn Tram. "Applications of fuzzy mufti-objective decision making in spatial load forecasting". *IEEE Trans. on Power Systems*, vol. 13, pp. 1185-1190, Mar, 1998.

[19] Allen J. Wood, Bruce F. Wollenberg. *Power Generation Operation and Control* (Book style), New York, John Wiley & Sons Inc., 2002.