Research On "three public" Dispatching Evaluation System Considering Energy Conservation and Emission Reduction

Tao Yu¹, Yupeng Huang², Bo Zhou³, Wenhui Zhao⁴, Ruan Li⁵* and Shangjia Wang¹

¹Shanghai Electric Power Trading Center Co., Ltd, Shanghai, 200000, China
²State Grid Shanghai Electric Power Company, Shanghai, 200000, China
³College of Electrical Engineering, Shanghai University of Electric Power, Shanghai, 200090, China
⁴College of economics and management, Shanghai University of Electric Power, Shanghai, 200090, China
⁵Shanghai Waigaoqiao No.3 Power Generation Co., Ltd, Shanghai,200137, China

*Corresponding author’s e-mail: ncepuliruan@163.com

Abstract. Currently, the existing evaluation indicators of "three public" dispatching only focus on the implementation of annual power generation plan, ignoring the efforts made by thermal power enterprises to participate in energy saving and emission reduction and cross-provincial and cross-regional power substitution in the implementation of power generation plan. In order to reasonably assess the dispatching completion of thermal power plants, a "three public" dispatching evaluation system based on efficient utilization of clean energy is proposed. The system is composed of power generation planning indicators, energy substitution indicators across provinces and regions, and emission reduction indicators. The efforts of thermal power enterprises to participate in energy saving and emission reduction and energy substitution across provinces and regions to promote energy efficient utilization are fully considered. Finally, the simulation results show that the validity and rationality of the "three public" dispatching evaluation system based on the efficient utilization of clean energy can provide ideas and directions for the design of "three public" dispatching indicators, which has a certain reference value.

1. Introduction

Power dispatching organization is the command organization of power production, transportation and distribution, which has an important impact on the trading subjects and transactions in the power market. In order to meet the security, stability and economic operation of the power system, and treat all market subjects equally in the principle of fairness and transparency, the power dispatching organization has set up an open, fair and just power dispatching system (referred to as "three public" dispatching degree for short)[1-2] based on its own internal management, and put forward corresponding management measures and assessment mechanism.

The assessment object of "three public" dispatching is the annual power generation plan issued by the government. Generally, the deviation between the annual power generation plan completion rates of all units is not more than 3%. From the perspective of power dispatching practice, all levels of
dispatching organizations can better complete the assessment task and achieve the "three public" dispatching goal [3-5]. However, with the continuous development of the scale of trans provincial and regional power trading market, only the annual power generation plan completion rate is taken as the evaluation index of "three public" dispatching, which makes the willingness of local units to carry out power generation right trading weak [6]. In order to effectively promote the consumption of clean energy across provinces and regions, it is necessary to optimize the current three public scheduling index system.

In the process of building a clean, low-carbon, safe and efficient energy system, the power system scheduling principle should be changed from the original "three public scheduling" to "clean, low-carbon and efficient scheduling" [7]. "Three public dispatching" mainly solves the fairness problem in the planned power distribution period, while "clean, low-carbon and efficient dispatching" needs to solve the efficiency problem by means of market. This efficiency is not only the efficiency of the power system, but also the whole social efficiency including environmental pollution, energy substitution and the completion of power generation plan among the main bodies in the power market. Therefore, the "three public" dispatching should not be limited to the completion of the power generation plan, but also fully evaluate the work of thermal power generation enterprises in the efficient use of clean energy. Therefore, a "three public" dispatching rating index system considering the trans provincial and regional power substitution and energy conservation and emission reduction should be established to adapt to the new situation of power dispatching under the background of energy system adjustment.

2. Evaluation index system of "three public" dispatching based on efficient utilization of clean energy

Specifically, the "three public" dispatching rating index system based on the efficient utilization of clean energy can be set up, which changes from the assessment of annual power generation plan to the competitive inspection of comprehensive evaluation index. The power generation plan index, trans provincial and regional energy substitution index and emission reduction index can be set to comprehensively evaluate the implementation level of "three public" dispatching of power generation enterprises.

2.1. "Three public" dispatching evaluation index

The annual power generation plan completion degree \( F_{ij} \) of power generation enterprise \( i \) in month \( j \) is defined as:

\[
F_{ij} = \frac{12 \times Fee_{ij}}{Fe} \times 100\%
\]  

(1)

In (1): \( Fee_{ij} \) is the actual generation capacity of power generation enterprise \( i \) in month \( j \), and \( Fe \) is the annual planned generation capacity of power generation enterprise.

The suitability index \( IN_{ij} \) of trans provincial and regional energy substitution of power generation enterprise \( i \) in month \( j \) is defined as:

\[
IN_{ij} = \frac{\sum_{k=1}^{j} \zeta_{ik}pe_{ik}}{\sum_{k=1}^{j} \zeta_{ik}} \times 100\%
\]  

(2)

In (2): \( \zeta_{ik} \) is the alternative generation capacity undertaken by power generation enterprise \( i \) in the \( k \) month; \( pe_{ik} \) is the landing price of the transfeeree of the trans provincial and regional direct transaction and power generation right transaction.
The completion degree $RE_{ij}$ of emission reduction of power generation enterprise $i$ in month $j$ is defined as:

$$RE_{ij} = \frac{\sum_{k=1}^{i} \zeta_{ik} \times Ce_{ik}}{\sum_{k=1}^{i} Re_{ik}} \times 100\% \quad (3)$$

In (3): $Ce_{ik}$ is the standard coal consumption of power generation in month $k$ of power generation enterprise $i$, and $Re_{ik}$ is the emission reduction index of power generation enterprise $i$ in month $k$.

2.2. "Three public" dispatching evaluation index $TD$

$$TD = \lambda_1 F_{ij} + \lambda_2 IN_{ij} + \lambda_3 RE_{ij} \quad (4)$$

In (4): $\lambda_i$ ($i = 1, 2, 3$) is the power generation plan completion, trans provincial and regional energy substitution suitability index, and the weight of the emission reduction completion degree, which meets the following requirements:

$$\lambda_1 + \lambda_2 + \lambda_3 = 1 \quad (5)$$

3. Example analysis

Take the monthly and annual power generation plan of six power plants in a power grid in East China as an example, the table of power generation completion is shown in Table 1, and the table of alternative power generation across provinces and regions is shown in Table 2, and the landing price of external power across provinces and regions is shown in Table 3.

Table 1. Monthly and annual power generation schedule of 6 power plants in a power grid in East China in 2017

| Month    | Power Generation / (GWh) |
|----------|-------------------------|
|          | A  | B  | C  | D  | E  | F  |
| January  | 586 | 320 | 554 | 566 | 406 | 372 |
| February | 538 | 210 | 608 | 331 | 512 | 380 |
| March    | 622 | 578 | 482 | 360 | 676 | 378 |
| April    | 483 | 569 | 350 | 522 | 594 | 369 |
| May      | 444 | 460 | 426 | 486 | 360 | 460 |
| June     | 542 | 517 | 600 | 614 | 533 | 587 |
| July     | 603 | 682 | 634 | 568 | 337 | 654 |
| August   | 517 | 616 | 604 | 589 | 540 | 601 |
| September| 357 | 436 | 605 | 546 | 502 | 505 |
| October  | 383 | 557 | 305 | 544 | 654 | 571 |
| November | 394 | 536 | 459 | 554 | 477 | 493 |
| December | 331 | 419 | 280 | 220 | 310 | 530 |
| Total    | 5900| 5901| 5897| 5900| 5901| 5900|
| Annual Generation Plan | 5900 | 5900 | 5900 | 5900 | 5900 | 5900 |

Table 2. Monthly alternative generation capacity of six power plants in a grid in East China in 2017

| Month    | Alternative Generation / (GWh) |
|----------|--------------------------------|
|          | A  | B  | C  | D  | E  | F  |
| January  | 126 | 126 | 147 | 105 | 13  | 11  |
According to the above indicators, weight $\lambda_1=\lambda_2=\lambda_3=1/3$, and the coal consumption is 308g/kWh, the completion degree of power generation plan is calculated as shown in Table 4, and the evaluation index of three public dispatching is shown in Table 5.

The traditional three public dispatching assessment is mainly aimed at the completion degree of power generation plan. According to this assessment mode, in 2017, the three public dispatching performance of six home appliance plants in East China ranked $B = E > A = D = f > C$.
According to the traditional generation plan completion degree, the ranking results of three public dispatching performance of six electrical appliances plants in East China in 2017 are b = E > A = D = f > C. Based on the "three public" dispatching evaluation index system of efficient utilization of clean energy, the performance sequence of three public dispatching of six power plants in an eastern region in 2017 is d > C > b > e > a > F. It is not difficult to find that this performance sequence is basically different from the traditional scheduling performance sequence of three public utilities according to the completion degree of power generation plan: the performance of power plants D and C which are replacing a large amount of electric energy has risen a level, which more fairly reflects the contribution of power plants actively participating in clean energy alternative power generation, and encourages power plants in East China to actively participate in clean energy alternative power generation Generation electricity generation.

The results show that the "three public" dispatching evaluation index system based on the efficient utilization of clean energy can comprehensively evaluate the completion of power generation, emission reduction and trans provincial and trans regional energy substitution of each power generation enterprise compared with the traditional "three public" dispatching evaluation system.

4. conclusion

With the gradual development of power market, the order of power transfer should be based on clean, low-carbon and efficient "three priority" dispatching. The "three public" dispatching evaluation index system based on clean energy and efficient utilization can improve the willingness of power generation enterprises to reduce emissions and the enthusiasm of participating in trans provincial and trans regional energy transactions, and achieve the maximum utilization of clean energy through co construction and sharing of dispatching mechanism. The main body of the market shares the benefits formed through optimization, which effectively connects the decisive role of the market and the role of the government.
Acknowledgment
The authors gratefully acknowledge the supports and provided by the project of State Grid Shanghai Electric Power Design Co., Ltd (A Study on the trading mechanism of power generation rights for clean energy consumption among provinces)

References
[1] Xie Bing, Huang liuqiang, Wu Yin, et al. Annual Rolling Generation Scheduling and Unit Commitment Optimization Model Based on Open and Impartial Dispatching [J]. Power System Protection and Control, 2017,45 (20): 110-116.
[2] Wei Xuehao, Hu Chaoyang, Yang Li. Analysis and Suggestions for Existing Evaluation Indices of Open and Impartial Dispatching [J]. Automation of Electric Power Systems, 2012, 36 (20): 109-112.
[3] Lu Zhigang, Yang Yu, Geng Lijun, et al. Low-carbon Economic Dispatch of the Integrated Electrical and Heating Systems Based on Benders Decomposition [J].Proceedings of the CSEE, 2018,38 (7): 1922-1934 + 2208.
[4] Mei Tianhua, Gan Deqiang. Market Model of Zhejiang Peak Load Regulation Market Based on Principles of Openness, Equity and Justness[J]. Journal of Zhejiang University (Engineering Science), 2016,50 (2): 369-376 + 396 .
[5] Wang Gang, Wu Yin, Yang Xiaowei, et al. Research and Application of the Impartial Open Thermal power Dispatch Model Considering Failure Rate and Market Transaction [J]. Machinery & Electronics, 2017,35 (5): 18-22.
[6] Yang Zhenglin, Tang Guoqing. A Generation Scheduling Optimization Model Suitable to Complete Period and Variable Intervals and Conforming to Principles of Openess, Equity and Justness [J]. Power System Technology, 2011,35 (2): 132-136.
[7] Yang Bi, Wang Jianjun, Lou Huahui, et al. "Three public" dispatching to build the cornerstone of power development [J]. China power enterprise management, 2017 (10): 84-85.