

The Analysis of Electricity Deployment Under the Government Involvement in Holidays

GAO Chen^{[a],*}; XIA Tianhong^[b]; DONG Yu^[b]; ZHONG Xiaoqiang^[a]; CHEN Yixin^[c];
 XU Dongdong^[b]

^[a]Fujian Electric Power Co., Fuzhou, China.

^[b]University of Science and Technology of China, Hefei, China.

^[c]Yili Technology Co., University of Science and Technology of China, Hefei, China.

*Corresponding author.

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Abstract

As the power load is less on holidays compared with the annual electricity load, we built a model to analyze the feasibility of the use of electricity for enterprises on holidays. This paper paid attention to the electric deployment under the government involvement. We set up a discounted electricity price, the industrial enterprises may restart production of the preferential tariff during holidays. It analyzed all of the situations that the power enterprises would like to do with the change of the public subsidies and encouragement of the government. It is helpful to deploy electricity and provide a reference for government to make a decision.

Key words: Electric deployment; Government involvement; Load shifting; Discounted electricity price; DSM

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INTRODUCTION

In recent years, along with the rapid development of China's economy and society, people's living standards continue to improve, accordingly, the demand for recreation and entertainment is growing. Under the guidance of the economic policy "encourage

consumption, stimulating domestic demand", the holiday system is gradually improving, so that the residents have plenty of time to waste away on recreation and entertainment, holiday consumption, which promotes holiday economy to emerge. As the most important basic energy industry in the national economic development, the electric power is in close relationship to the social and economic development and residents' daily life. The development of holiday economy is bound to have a greater impact on the electric power supply and demand, so that the holiday electricity shows some peculiarities. Among all of the holidays, the Spring Festival and the National Day which are the longest and the greatest impact holidays, their effect on the electric power supply and demand is particularly significant. As shown in Figure 1, the annual grid load was in the period of valleys in February and October, at which time the Spring Festival (February) and the National Day (October) is, that reflects some impact of holidays on electric power.

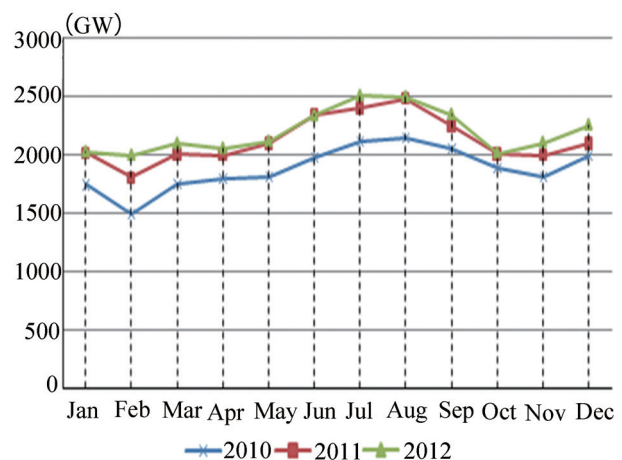


Figure 1
 2010-2012 Annual Load Flow of One Province in China

Actually, according to the existing research achievements, we can get the main effects of holidays on power demand and supply are: a) The total electricity load level drops during the holidays. b) The total power consumption during declines the holiday. c) The daily load curve shape during the holiday is markedly different from normal days, which highlights the difference of the load curve peaks' value and valleys' value, and the different time period when they happen. The reasons mainly include the following factors: a) During the holidays, some industrial enterprises stop production, the industrial and office electrical demand decline; b) The flow and distribution of personnel during the golden leisure and tourism holiday result in the rise of residential and commercial electrical demand.

In the article "The Analysis of Electricity Deployment if the Enterprise is working in Holidays", we have discussed about that the power supply enterprises can set up a discounted electricity price during the holidays to encourage some industrial enterprises to restart production. Through the economic lever, the power grid can achieve the benefit of valley-filling and peak-shifting. From that paper, we can get the conclusion that the more discounted electricity price which power supply enterprises give, there is the more possibility of a industrial enterprise restarting production during holidays and the more number of industrial enterprises would like to restart production, so that the power grid can achieve more valley-filling.

However, there are some problems remaining to be

resolved: a) Giving a discounted electricity price means the power supply enterprises have to surrender part of the profits to the industrial enterprises. Although the power supply enterprises can profit from the valley-filling, they may still lack enough motivation to do this measure, especially when some power supply enterprises take this way while the others not, the total effect will be weak. b) The capacity of the power supply enterprises is limited. If the discounted electricity price set too low, there may be few industrial enterprises would like to restart production during holidays. Oppositely, if the discounted electricity price set too high, there would be little power supply enterprises take this measure as they can't get benefit from it.

So, in this paper, we will talk about how to solve the conflicts. Naturally, we would like to look into our government, who has enough ability to take this measure and can also achieve benefit from the grid of valley-filling and peak-shifting. So, we will study how the electricity can deploy under the government involvement and what role the government can play in the holiday electricity.

1. GAME MODEL WITHOUT GOVERNMENT INVOLVEMENT

Firstly, let's begin from the discussion about the cost and benefit of the stakeholders involved in the measure of restarting production during holidays, including the power supply enterprises, the industrial enterprises and the staffs of the industrial enterprises, just as shown in Table 1.

Table 1
The Cost and Benefit of the Stakeholders Involved in the Measure of Restarting Production During Holidays

Stakeholders	Cost	Benefit
The power supply enterprises	The electricity income will reduce after carrying out the preferential tariff in the holidays.	Benefit from the valley-filling, including improving power grid load rate, improving the reliability of power supply, reducing the loss and saving energy, etc..
The industrial enterprises	Mainly the increase of labor costs, the cost of the enterprises arranging the production.	The drop of the electricity cost of the industrial production, the profits more production brings and the profits from the changes price of market after adjusting production.
The staffs of the industrial enterprises	Time cost of the holidays completely or partially expends, not enjoying holidays	The economic benefits of the multiple compensation, adjust time to rest.

As what mentioned before, giving a discounted electricity price means the power supply enterprises have to surrender part of the profits to the industrial enterprises. Although the power supply enterprises can profit from the valley-filling, they may still lack enough motivation to do this measure, especially when some power supply enterprises take this way while the others not, the total effect will be weak. We can divide all of the power supply enterprises into two categories: *A* who take the measure and *B* who don't take the measure. Then, we can get the profit analysis as follows:

a) *A* and *B* both take the measure, so that the grid valley-filling is very effective and the average discounted

electricity price that every power supply enterprise should set up is lower. We use *T* representing the benefit of every power supply enterprise.

b) *A* take the measure and *B* don't take the measure, or the opposite. The grid valley-filling is weak. The ones who take the measure have to cost more to fill the grid load valley, so that their total benefit from the grid valley-filling will be very low and even the negative. We use *L* representing the benefit of these power supply enterprises. On the other hand, the others who don't take the measure will also benefit from the grid valley-filling without the cost of the discounted electricity price. So, they can get a higher benefit, using *H* to represent.

c) Both A and B don't take the measure. Then, both of them can't get benefit from the grid valley-filling, meanwhile they also have no cost of the discounted electricity price. We use N representing the benefit of them.

Do not break general, we can get $H > T > N > L$. And without the government involvement, we can get the beneficial matrix of the power supply enterprises as shown in Table 2.

Table 2
The Beneficial Matrix of the Power Supply Enterprises

$A \backslash B$	Take the measure	Don't take the measure
Take the measure	T, T	L, H
Don't take the measure	H, L	N, N

From the table, we can get the "Nash balance" is (N, N) , which means all of the power supply enterprises will lack the motivation to take the measure of setting up a discounted electricity price during the holidays to encourage some industrial enterprises to restart production. That is bad for the power grid and the social welfare. So, we need the help of the government.

2. GAME MODEL WITH GOVERNMENT INVOLVEMENT

To begin with, we will talk about why the government would like to involve in the measure. As the most important basic energy industry in the national economic development, the electric power is in close relationship to the social and economic development and residents' daily life. Taking the measure to encourage the industrial enterprises to restart production during holidays can fill the grid load valley, so that improving power grid load rate, improving the reliability of power supply, reducing the loss and saving energy, producing evident economic, environmental and social benefits.

Secondly, we will discuss about what measures the government can take to involve in the restarting production during holidays, including positive measures and punitive measures. The positive measure is that the government can give public subsidies to the power supply enterprises taking the measure, so that the power supply enterprises have enough resources to set up a higher discounted electricity price to attract more industrial enterprises take part in and the load valley can fill more. The benefits are passed from the power supply enterprises into the industrial enterprises, and into the staffs of the industrial enterprises, all of them can benefit from this way. We use P representing the public subsidies that the government give. The punitive measure is that the government can set up an assessment index of the grid load trend, under which the power grid valley value is, the power supply enterprises will get the punishment, using F representing the fine. Then, we can get a new

beneficial matrix of the power supply enterprises with the government involvement as shown in Table 3.

Table 3
The Beneficial Matrix of the Power Supply Enterprises Government Involvement

$A \backslash B$	Take the measure	Don't take the measure
Take the measure	$T+P, T+P$	$L+P, H-F$
Don't take the measure	$H-F, L+P$	$N-F, N-F$

Assuming the ratio of the power supply enterprises taking the measure is x , the ratio not taking is y , then we can know $x+y=1$, according to the evolutionary game theory, we can get the fitness function of the power supply enterprises taking the measure is:

$$W1 = x(T+P) + y(L+P) = xT + yL + P$$

The fitness function of the power supply enterprises not taking the measure is:

$$W2 = x(H-F) + y(N-F) = xH + yN - F$$

The average fitness function is:

$$\bar{W} = xW1 + yW2$$

$$\dot{x} = x(W1 - \bar{W}) = xy(W1 - W2)$$

$$= x(1-x)[(T-H+N-L)x + L - N + P + F]$$

$$\dot{y} = y(W2 - \bar{W}) = xy(W2 - W1)$$

$$= y(1-y)[(T-H+N-L)y + H - T - P - F]$$

As $x+y=1$, this paper will only analyze the x , combining the theories of power system, we can get the conclusions as follows:

Proposition 1 if $P+F \geq \max\{H-T, N-L\}$, the system (1) has two balance points: $x1=0$, $x2=1$, and $x2=1$ is the local gradual balance point of the system (1), $x1=0$ is not.

Proposition 2 if $\min\{H-T, N-L\} \leq P+F \leq \max\{H-T, N-L\}$, the system (1) have three balance points: $x1=0$, $x2=1$,

$$x3 = \frac{(L-N+P+F)}{(H-T+L-N)}$$

(a) when $H-T > N-L$, i.e., $N-L < P+F < H-T$,

$x3 = \frac{(L-N+P+F)}{(H-T+L-N)}$ is the local gradual balance point of the

system (1), $x1=0$ and $x2=1$ are not.

(b) when $H-T < N-L$, i.e., $H-T < P+F < N-L$, $x1=0$ and $x2=1$ are the local gradual balance points of the system (1),

$x3 = \frac{(L-N+P+F)}{(H-T+L-N)}$ is not.

Proposition 3 if $P+F \leq \min\{H-T, N-L\}$, the system (1) has two balance points: $x1=0$, $x2=1$, and $x1=0$ is the local gradual balance point of the system (1), $x2=1$ is not.

3. THE ANALYSIS OF PARAMETER

In this part, we will analyze the parameter including T, L, H, N, P, F .

$$P+F \geq \max\{H-T, N-L\}, \quad (1)$$

where, P represents the positive effect of the government, and F represents the punitive effect. P, F play an important role in the choice of power supply enterprises to take the measure or not. If the public subsidies and

punishment of the government are high enough, i.e., $P+F$ is higher enough than $\max\{H-T, N-L\}$, we have $T+P > H-F$ and $L+P > N-F$. According to the Table 3, we can get the conclusion that the power supply enterprises choosing to take the measure benefit more, so all of the supply enterprises will choose to take. As shown in Figure 2, two curves are given in which the initial value is 0.2 and 0.8, and the steady state of both of them is $x=1$.

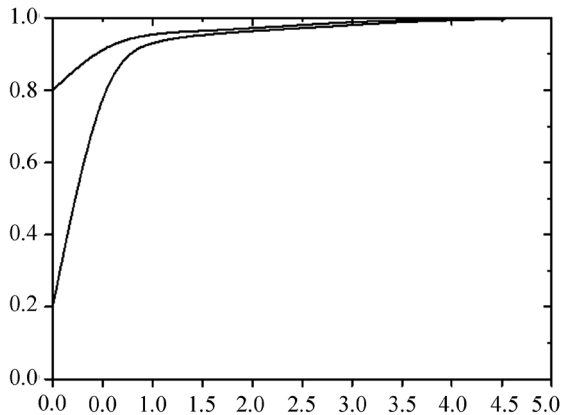


Figure 2
 $P+F \geq \max\{H-T, N-L\}$

$$\min\{H-T, N-L\} \leq P+F \leq \max\{H-T, N-L\} \quad (2)$$

In this case, the number of $H-T$ and $N-L$ can make a difference to the evolutionary stable state.

(a) When $N-L < P+F < H-T$, we have $N-F < L+P$ and $T+P < H-F$. According to the Table 3, we can get the conclusion that when the others choose to not take the measure, the power supply enterprises choosing to take the measure benefit more, oppositely, when the others choose to take the measure, the power supply enterprises choosing to not take the measure benefit more. When the system come to the evolutionary stable state, there will be $x = \frac{(L-N+P+F)}{(H-T+L-N)}$ ratio of the power supply enterprises choose to take the measure. As shown in Figure 3, two curves are given in which the initial value is 0.2 and 0.8, if $H-T=5$, $P+F=4$, $N-L=2$, the evolutionary stable state is $x=2/3$, it means that there will be 66.7% of the power supply enterprises choose to take the measure, 33.3% not.

(b) When $H-T < P+F < N-L$, we have $H-F < T+P$ and $L+P < N-F$. According to the Table 3, we can get the conclusion that when the others choose to not take the measure, the power supply enterprises choosing to not take the measure benefit more, oppositely, when the others choose to take the measure, the power supply enterprises choosing to take the measure benefit more. When the system come to the evolutionary stable state, there will be two possible results: all of the power supply enterprises choose to take the measure or all not. As shown in Figure 4, three curves are given of which the initial value is 0.2, 0.5 and 0.8. When the initial value is 0.2, 0.5, the steady state is $x=0$. When the initial value is, the steady state is $x=1$. The evolutionary stable state is related to the initial value.

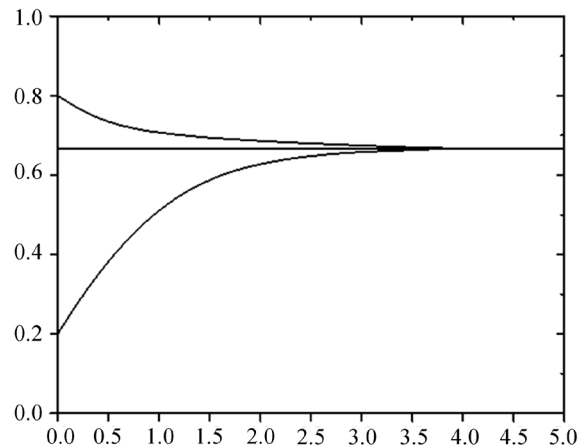


Figure 3
 $N-L < P+F < H-T$

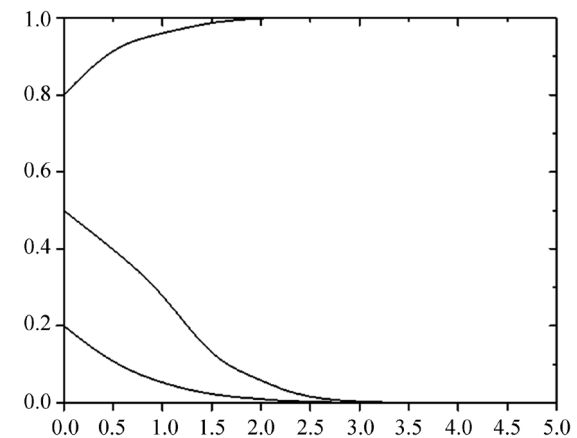


Figure 4
 $H-T < P+F < N-L$

(c) $P+F \leq \min\{H-T, N-L\}$ we have $L+P < N-F$ and $T+P < H-F$. According to the Table 3, we can get the conclusion that the power supply enterprises choosing to not take the measure benefit more as the public subsidies and punishment of the government are not enough high. As shown in Figure 5, two curves are given of which the initial value is 0.2 and 0.8, the steady state both of them are $x=0$.

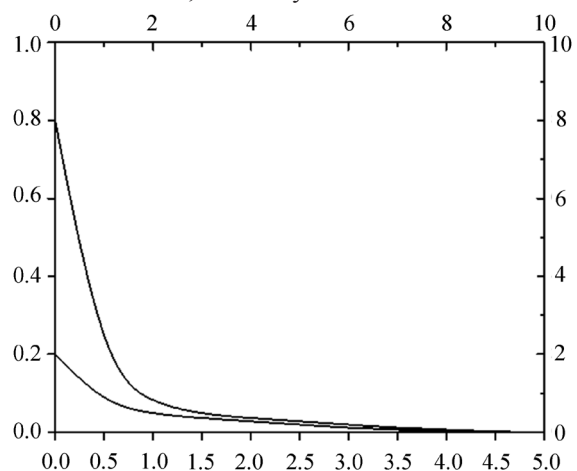


Figure 5
 $P+F \leq \min\{H-T, N-L\}$

CONCLUSION

In this paper, we have studied what choice the power enterprises would like to do under the government involvement. The government can take positive measures and punitive measures to participate in the electricity deployment if the industrial enterprises restart production during the holidays. As shown in Table 4, it turned out that the steady state of the system will present the following situations with the change of the public subsidies and punishment of the government:

a) When the public subsidies and punishment $P+F$ is high enough so that all of the power supply enterprises will choose to take the measure. b) When the public subsidies and punishment $P+F$ is less, the choice is related to the initial value. c) When the public subsidies and punishment $P+F$ is too low so that all of the power supply enterprises choose to not take the measure. The conclusions have analyzed and explained all of the situations, which can be as a reference for decision making of the government.

Table 4
The Choice of the Power Enterprises With the Government Involvement

The change of the public subsidies and punishment of the government	The steady state	The choice of the power enterprises
$P+F \geq \max\{H-T, N-L\}$	$x=1$	all of the power supply enterprises choose to take the measure
$N-L < P+F < H-T$	$x = \frac{(L-N+P+F)}{(H-T+L-N)}$	$x = \frac{(L-N+P+F)}{(H-T+L-N)}$ ratio of the power supply enterprises choose to take the measure
$H-T < P+F < N-L$	$x=0$ or $x=1$, it is related to the initial value	All of the power supply enterprises choose to take the measure or all not
$P+F \leq \min\{H-T, N-L\}$	$x=0$	All of the power supply enterprises choose to not take the measure

Taking the measure to encourage the industrial enterprises to restart production during holidays can fill the grid load valley, so that improving power grid load rate, improving the reliability of power supply, reducing the loss and saving energy, producing evident economic, environmental and social benefits. Further study can pay close attention to the public subsidies and punishment of the government for the industrial enterprises and the staffs, so that the electricity deployment can connect with the government, the power supply enterprises, the industrial enterprises and the staffs to maximize the social benefits.

REFERENCES

Gao, Z. H., Ren, Z., & Huang, W. Y. (2006). Market participants in the electric power supply tense period of benefit analysis. *Journal of South China University of Technology (Natural Science Edition)*, 34(4).

Jia, J. G., Zhang, X. H., & Ye, C. (2007). Effects on electric power supply and demand characteristics by holidays in 2007. *Power Demand Side Management*, 9(6).

Lin, H., Liu, J., & Hao, Z. F., et al. (2010). Based on the similar day load fixed holidays of short-term load forecasting. *Power System Protection and Control*, 38(7), 1.

Liu, W. F., Gao, W., & Jia, J. G., et al. (2006). Study of rules, standards and incentive mechanisms in implement of power demand side management in China. *Power System Technology*, 30(Suppl.).

Suo, L., Ding, Q., & Chao, X. Y. (2009). Holiday load forecast based on the fuzzy reasoning. *Electric Power*, 42(11).

Tai, Y. (2009). The government involved in electric power resource allocation under the conditions of the market economy mode. *Science of Guangdong (Electric Construction)*, (217).

Wang, F. S., & Wang, Y., & Zhen, Z. (2009). Based on the government involvement in electric power enterprise income distribution of supply chain research. *Study and Explore*, 2.

Zhang, Y. F., Zhao, S. H., & Mao, L. P., et al. (2005). The role and function of the government in implementing DSM. *Power Demand Side Management*, 7(2).

Zhou, F. Q., & Xia, X. (2012). Key missions of comprehensive DSM city pilot and financial incentive policies. *Power DSM*, 14(5).