

# Research on power source structure optimization for East China Power Grid

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**Abstract.** The structure of east china power grid is not reasonable for the coal power takes a much higher proportion than hydropower, at present the coal power takes charge of most peak load regulation, and the pressure of peak load regulation cannot be ignored. The nuclear power, wind power, photovoltaic, other clean energy and hydropower, coal power and wind power from outside will be actively developed in future, which increases the pressure of peak load regulation. According to development of economic and social, Load status and load prediction, status quo and planning of power source and the characteristics of power source, the peak load regulation balance is carried out and put forward a reasonable plan of power source allocation. The ultimate aim is to optimize the power source structure and to provide reference for power source allocation in east china.

## 1. Introduction

The east china power grid is one of the largest provincial power grids in china which is composed of Shang hai, Jiang su, Zhe jiang, and a Hui and Fu jian province. The structure of east china power grid is not reasonable for the coal power [1]. Takes a much higher proportion than hydropower [2], at present the coal power takes charge of most peak load regulation. There are some shortcomings such as the economy is poor and the operation safety and stability of the unit is reduced in peak load regulation by coal power. In order to meet the increasing power demand of East China Power Grid, The coal power, nuclear power, wind power, photovoltaic, other clean energy and hydropower, coal power and wind power from outside will be actively developed in future. For nuclear power is suitable for base load operation, the output of wind power and other new energy [3]. Is randomness, the electric power from outside is aim to send electricity and do not assume the task of peak load regulation, those factors will lead to a phenomenon that the proportion of peak load regulation power source may be seen further declined.

The variation rule [4]. Of electric power in east china power grid is gained by analysis of social economy and energy resources, load and electricity consumption of the power grid. The power demand [5]. In 2025 is predicted combined with load prediction result of east china power grid. The status quo and planning of power source is arranged and optimization model of power source structure is established. Then the electric power market, peak load regulation capacity [6]. And the comparison result of peak load regulation power source are obtained. Based on the optimization for power source structure, the reasonable power source allocation in east china is obtained at last.



## 2. Load prediction

The load of east china power grid is predicted by analysis of electricity consumption, the relationship between variation rule of electric power structure and economic growth. The result of load prediction is shown as below.

**Table 1.** The load prediction of east china power grid

Item	2015	2020	2025
The maximum load(MW)	235000	305000	370000
Growth rate (%)		5.35	3.94
Annual power demand(billion kWh)	1400	1800	2150
Growth rate (%)		5.15	3.62

Through analysis of status quo of east china power grid in recent years, It can be found that the peak load in summer usually occurred in July, August and September, mostly in August, and the peak load in winter usually occurred in December; The evening peak load of each month is often higher than early peak load, usually the evening peak load occurred at pm19~20 in summer and pm18~19 in winter. It is predicted that daily load rate of typical days in summer and winter is between 0.798 and 0.834, the daily minimum load rate is between 0.595 and 0.634.

## 3. The analysis peak load regulation balance

The amplitude of power source in east china power grid are as follows:

(1) Conventional hydropower station: The amplitude of peak load regulation of large and medium-sized hydropower stations can reach to 100%, the small hydropower stations are incapable to regulate peak load.

(2) Pumped storage power station: The amplitude of peak load regulation can reach to 200% of its boot capacity.

(3) Coal power: The amplitude of peak load regulation of large coal units can reach to 40~50%. The small coal units are considered as base load which has no capacity of peak load regulation.

(4) Gas power: The amplitude of peak load regulation can reach to 100% of its boot capacity. Thermal units are considered as base load.

(5) Nuclear power: The nuclear power is considered as base load.

(6) Wind power: The anti-rate of peak load regulation is 45%.

(7) Hydropower from outside: The hydropower from outside bear base load in flood season and take some charge of peak load regulation in dry season.

(8) Coal power from outside: It is considered as base load.

The calculation of peak load regulation balance of east china power grid in 2025 is carried out on the base of above principle, the results are shown in the table below.

The calculated result indicates that the peak valley difference of east china power grid will significantly increase in future With the increase of nuclear power, wind power, other new energy sources and electric power from outside, the amplitude of coal power in future will be high and the pressure of peak load regulation cannot be ignored. It is hard to is difficult to satisfy with the request of Safe, stable and economical operation of power grid. It is an urgent need to build peak load regulation power source.

**Table 2.** The peak load regulation balance of east china power grid in 2025(Unit: MW)

	item	
1	Maximum load	370000
2	Minimum load rate	0.6340
3	Maximum peak valley difference	136159
4	hot-spare	27900
5	Anti-spare of wind	11025
6	Required capacity of peak load regulation	175084
7	Total boot capacity	399900
	Conventional hydropower	14722
	Pumped storage power station	13220
	Gas power	31169
	Oil power	857
	Nuclear power	39920
	Wind power	1225
	Hydropower from outside	26326
	Coal power from outside	49980
	Small Coal power	24861
	Coal power which can regulate peak load	197620
8	Required capacity of peak load regulation	175084
	Conventional hydropower	6828
	Pumped storage power station	26440
	Gas power	12085
	Coal power which can regulate peak load	129732
9	Amplitude of coal power(%)	65.6
10	Capacity of coal power when amplitude of coal power is 35%	69167
	The profit and loss of capacity of coal power(+ is profit - is loss)	-60565

#### 4. The optimal allocation of power source

On the base of power source which participate in peak load regulation, adjusting the scale of coal power, gas power and pumped storage power stations, maintaining the scale of other power sources to carry out optimal allocation of power source in east china power grid. The result shows that total discounted cost of Pumped storage power station is the least. When the scale of Pumped storage power station is 40000MW, the amplitude of coal power decreased from 65.6% to 44.6%, which means that Pumped storage power station takes a good effect on peak load regulation.

**Table 3.** Reasonable scale of Pumped storage power station in east china power grid in 2025

scheme	Reasonable scale of Pumped storage power station (MW)	New scale of Pumped storage power station (MW)	Scale of gas power (MW)	New scale of gas power (MW)	scale of coal power (MW)	Total discounted cost (billion RMB)	utilization hours of coal power(h)	Coal consumption (thousand tons)	Gas consumption (billion m3)	Amplitude of coal power (%)	
										summer	winter
M1	13220	0	38961	0	218609	2259.3	4598	313570	27.55	65.6	59.9
C1	22000	8780	38961	0	209411	2238.7	4823	312690	27.55	59.4	53.8
C2	40000	26780	38961	0	191060	2213.7	5339	311020	27.55	44.6	40.0
C3	46000	32780	38961	0	185513	2214.2	5517	310630	27.55	38.9	34.8
R1	13220	0	47741	8780	209411	2287.1	4653	302150	33.75	64.2	58.1
R2	13220	0	65741	26780	190554	2344.6	4783	278920	46.48	60.7	54.1
R4	13220	0	71741	32780	184281	2364.4	4832	271280	50.72	59.5	52.6

The effect of different amplitude of coal power act on the scale of Pumped storage power station is analysed on base of optimization for power source structure. At the same time, the different amplitude

of thermal units, gas power, nuclear power, hydropower from outside, coal power from outside act on the scale of Pumped storage power station is analysed too. When the amplitude of hydropower from outside is 20%, the amplitude of coal power from outside is 30%, the amplitude of thermal units is 20%, the amplitude of nuclear power is 10%, the reasonable scale of Pumped storage power station is 32318MW; When hydropower from outside, coal power from outside, thermal units, nuclear power don't participate in peak load regulation, and take wind power from outside into consideration, the reasonable scale of Pumped storage power station is 60017MW. By analysis of the economic efficiency of power system, capacity and possibility of peak load regulation and uncertainty of electric power from outside, this article presents that the reasonable scale of pumped storage power station is 40000MW, and the proportion of pumped storage power station is 8.1%.

The optimal allocation of power source of east china power grid in 2025 is as follows:

**Table 4.** The optimal allocation of power source of east china power grid in 2025

Item	2025	
	Scale of power source(MW)	Proportion (%)
Maximum load	370000	
Assemble power	490889	100
Conventional hydropower station	19932	4.1
Pumped storage power station	40000	8.1
Gas powe	38961	7.9
Nuclear power	39920	8.1
Wind power	24500	5.0
Coal power from outside	56300	11.5
Hydropower from outside	40800	8.3
Coal power	230476	46.9

## 5. Conclusion

The structure of east china power grid is not reasonable for the coal power takes a much higher proportion, The capacity of peak load regulation is obviously different in all kinds of power source, demand of electricity continues to increase, peak valley difference will increase significantly and the pressure of peak load regulation cannot be ignored. By analysis of optimal allocation of power source, it shows that the reasonable scale of pumped storage power station is 40000MW, and the proportion of pumped storage power station is 8.1%. If the power source planning carried out according to the idea of peak load regulation balance, the power source structure of east china power grid in future will be better and better. The method can play an important role in guiding for the planning work in east china power grid.

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