Study on the application of shutdown factors to investment management of 35 kV and above power grid infrastructure projects

Ming Zhou^{1*}, Shengwei Lu¹, Qiang Wu¹, Sha Jin¹, Jiong Yan², Zixia Sang²

¹State Grid Hubei Electric Power Co., Ltd, Wuhan, Hubei, 430077, China

²Hubei Economic Research Institute of State Grid Hubei Electric Power Co., Ltd, Wuhan, Hubei, 430000, China

Abstract. With the strengthening of external supervision and the management requirements of internal quality and efficiency improvement of power grid, it is particularly important to improve the lean level of power grid investment. However, the accuracy and scientificity of the current grid infrastructure project investment plan adjustment need to be further improved, and the basis for the completion of investment submission is the on-site construction progress. Therefore, this topic carries out the analysis of the factors affecting the construction progress, including the types of the factors affecting the construction, the depth and breadth of the impact, and the impact of the milestone stage, and takes the analysis results of the shutdown factors as the reference basis for the adjustment of the investment plan, so as to improve the investment management level of the company.

1 Introduction

At present, the State Grid Corporation of China is constantly improving the level of investment lean management. As an important part of investment management, the accuracy of investment forecast in the remaining construction period will have a significant impact on the accurate allocation of its investment resources. The basis for the completion of investment submission is the on-site construction progress, which is affected by many factors. If the power grid infrastructure project is hindered by working hours, it is important to predict its impact on the completion of the investment plan, and then give more accurate investment plan adjustment suggestions.

Under the above background, the research is carried out. Firstly, taking the power grid infrastructure projects of 35kV and above as the research object, the influencing factors of shutdown are classified. Secondly, based on the shutdown sample data, the number and duration of project downtime affected by various factors are analyzed. Finally, the analysis results of shutdown factors are applied to the construction schedule prediction and investment plan adjustment of power grid infrastructure projects, so as to further improve the level of power grid investment management.

2 Classification of factors affecting shutdown

According to the construction experience of power grid infrastructure projects, this paper summarizes and refines

the on-site construction resistance factors of construction progress. According to the different participation degree and influence mode of various factors in the project construction process, they are divided into external factors and internal factors. The external factors are divided according to the main body, mainly including government, social factors, suppliers, contractors, supervision units and natural factors. The internal factors mainly refer to the attributes of substation, technical factors, design conditions, bidding, contract management, capital guarantee and management factors, which are shown in the table below.

Table 1. Influencing factors of power grid infrastructure project shutdown.

Factor categories	Subject factor	Specific factors
External factors	Government	Opinions on route routing and land use permission approved by the planning department, etc
		Site change
		Procedures involved in handling construction permit
	Social factors	Occupation of farmers' cultivated land
		Land acquisition
		Compensation for young crops
		User relocation and relocation

* Corresponding author: Zhoun50@hb.sgcc.com.cn

	Supplier	Crossing or adjacent to the Cultural Nature Reserve
		Arrival of equipment and materials
		Quality of supplier's production equipment
	Contract or	Project management personnel experience and management level
		Number and technology of construction personnel
		Construction scheme and construction process arrangement
	Construct ion control unit	Qualification, experience and professional level of supervision engineer
		Organization and coordination ability and responsibility
	Natural factors	Geological conditions
		Topographical conditions
		Traffic conditions
Factor categories	Subject factor	Specific factors
External factors	Natural factors	Hydrometeor
		Elevation of station site
		Special climate
		Seasonal factors (winter construction, peak summer)
	Emergen cy	Natural disaster
		Major political, social and economic changes
Internal factors	Substatio n propertie s	Type and capacity of Substation
		Is it a prefabricated substation
		Is it an intelligent substation
	Technical factors	Quantity of cableway transportation
		Line fold length
		Number of three span and large span
		Insufficient technical support
	Design factors	Design change
	Bidding	Bidding is not timely
		Bidding time and project start time are not closely linked
	contract managem ent	Project claim
		Contract dispute
		Performance

	Fund guarantee	Insufficient funds for purchasing raw materials
		Project payment shall be made on time
	Manage ment factors	Blackout plan
		Examining and approving formalities
		Experience and technology of construction personnel
		Organization and coordination ability

3 Data analysis of factors affecting shutdown

On the basis of the above-mentioned general shutdown factors, the relevant shutdown project data of a provincial power company during the historical period (including the start time of shutdown application, the end time of shutdown, the reason of shutdown application, etc.) are collected from the infrastructure management and control system. The specific factors affecting the shutdown are shown in the table below, and the overall analysis and milestone stage analysis of shutdown factors are carried out.

Table 2. Classification of factors affecting shutdown.

Factor categories	Subject factor	Specific factors
External factors	Government	Local coordination
		Planning adjustment
	Social factors	Civil mediation
		Land acquisition
		Holiday and vacations
	Supplier	Arrival of equipment and materials
	Contractor	Construction process arrangement
	Natural factors	Meet the peak in summer
		Cold winter shutdown
	Emergency	Epidemic situation
Internal factors	Construction control unit	Construction coordination
	Management factors	Blackout plan
		Organization and coordination ability
		Experience and technology of construction personnel

3.1. Analysis of shutdown factors

(1) Analysis of the main factors affecting the shutdown:

Among the main factors that affect the work stoppage, the influencing factors are: supervision unit (78 samples), social factors (58 samples), management factors (43 samples), etc.

Figure 1. Different factors affect the number of project downtime

Among the main factors influencing the work stoppage, the most influential factors are: management factors (the average duration of suspension is 2.3 months), the supervision unit (2.2 months), and the government (2 months). Captions should be typed in 9-point Times. They should be centred above the tables and flush left beneath the figures.

Figure 2. Different factors affect the duration of project downtime

(2) Analysis of specific factors affecting shutdown:

● Analysis of specific external factors

Among the specific external factors, the influencing factors are: construction coordination (78 samples), holidays (44 samples), winter cold (17 samples), and poll (12 samples).

Figure 3. External factors affect the number of project downtime

Among the external factors, the more influential factors are: the public opinion survey (average downtime of 4.5 months), peak summer (2.4 months), construction coordination (2.2 months), and local coordination (2.1 months).

Figure 4. External factors affect the duration of project downtime

● Analysis of internal specific factors

Internal specific factors mainly include power outage plan, construction personnel experience and organization and coordination ability. Among them: outage planning factors (36, 2.7 months); construction personnel experience and Technology (6, 0.7 months); organization and coordination ability (1, 0.5 months).

Figure 5. Internal factors affect the duration of project downtime

Figure 6. Internal factors affect the duration of project downtime

The results of the above analysis are summarized as follows:

Table 3. Summary of the number and duration of project downtime affected by various factors.

Specific factors	Influence of various factors on shutdown duration (months)	Various factors affect the number of work stoppages (number)
Local coordination	2.1	4
Planning adjustment	1.8	4
Civil mediation	4.5	12
Land acquisition	2.1	2

Holiday and vacations	0.9	44
Arrival of equipment and materials	1.9	8
Construction process arrangement	1.0	2
Meet the peak in summer	2.4	5
Cold winter shutdown	1.2	17
Epidemic situation	1.1	3
Construction coordination	2.2	78
Blackout plan	2.7	36
Organization and coordination ability	0.5	1
Experience and technology of construction personnel	0.7	6

3.2 Analysis of specific factors affecting shutdown in each milestone stage

On the basis of the above analysis of shutdown factors, the shutdown time is matched with the information of the milestone stage of the project, and the influence of different factors on the construction stage of the project is further studied, and the shutdown factor analysis of milestone stage is carried out according to the project type.

(1) Substation engineering

● Start up stage: meet the peak in summer (2 samples, affecting the average shutdown time of 2.5 months), holiday and vacations (1, 2 months), blackout plan (7, 2.6 months)

● Civil engineering stage: cold winter shutdown (1 month, 1 month), meet the peak in summer (1 month, 1.5 months), blackout plan (2, 1.5 months), construction coordination (3, 0.5 months)

Figure 7. Analysis of shutdown factors in each milestone stage of substation project

(2) Line engineering

● Start up stage: civil mediation (2, 3 months)

● Foundation excavation stage: construction coordination (3, 1.1 months), blackout plan (2, 1.3 months), meet the peak in summer (1, 1.9 months), holiday and vacations (2, 0.5 months)

● Foundation pouring stage: civil mediation (1 month, 3 months)

● Tower assembly stage: blackout plan (1 month, 1 month)

● Stringing construction stage: arrival of equipment and materials (1 month, 2 months)

Figure 8. Analysis of shutdown factors in each milestone stage of line project

4 Analysis and application of shutdown influencing factors

Based on the analysis of shutdown factors and duration of power grid infrastructure projects, this paper summarizes the influence law of downtime duration on key milestone nodes, which is applied to the construction schedule prediction and investment plan adjustment of power grid infrastructure projects.

Construction schedule prediction: considering the factors and duration of each milestone stage shutdown, reasonable setting of shutdown duration parameters can improve the accuracy of construction progress prediction.

Adjustment of investment plan: in case of blocked working hours of power grid infrastructure projects, the influence degree of shutdown factors and duration on the completion of investment plan is predicted, and then more accurate investment plan adjustment suggestions are given.

5 Conclusion

This project takes the power grid infrastructure projects of 35kV and above as the research object, analyzes the influence of various factors on the number and duration of project downtime based on the actual shutdown sample data of power grid company, and corresponding the shutdown factors to each milestone stage, which provides effective means for the scientificity of construction progress prediction and further improves the power supply Accuracy of investment forecast for network infrastructure projects.

References

- W. Xie, D. Zhang, H.D. Du, W.M. Pan, C.G. Cao, Engineering construction and design, Construction of adjustment model for mid year investment plan of power grid infrastructure projects, (02): 206-207, (2020)
- W.J. Cui, C.J. Qu, China management informatization, Dynamic monitoring and control mechanism of power grid project progress and duration, 20 (24): 63-64, (2017)
- A.Y. Li, Journal of Nanjing Normal University, Study on planning and control of power grid

construction project under construction period
constraint, 16 (01): 89-92, (2016)

4. X.M. Kong, Science and technology and industry,
Review on investment optimization of power grid
construction projects, 19 (05): 100-104, (2019)