

Research and Application of Connection Mechanism Model Between Investment Plan and Budget of Power Grid Infrastructure Project

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Abstract—The purpose of this research is to solve the management problem of "the two skins of investment plan and budget", promote the collaborative management of various disciplines, improve the overall management efficiency of investment projects, actively respond to the impact of internal and external environments, and realize the convergence of investment plans and investment budgets. In order to achieve the above objectives, the management characteristics of investment plans and budgets and professional business requirements are considered through overall planning, and the construction schedule is used as the time node basis for model preparation. Based on the characteristics of the time distribution of investment plans and investment budgets, combined with the differences in the timing and proportions of the four expenses, this research puts forward clear recommendations for the preparation of annual investment plans and budgets. This project forms a set of model tools that are easy to use by prefectures and cities by constructing a model of the linkage mechanism between investment plans and budgets, and promotes collaborative management between disciplines.

Keywords-investment plan; investment budget; construction progress; cohesion mechanism

1 INTRODUCTION

Based on non coordination of plan management among multiple disciplines, combined with the law of construction period and the law of cost entry in different milestone stages, and considering the quantitative law of investment plan and investment budget, the preparation and adjustment model of investment collaborative management and control is constructed. The purpose of this topic is to meet the requirements of transmission and distribution price reform and investment management of the national development and Reform Commission, achieve the goal of collaborative management and control, and meet the requirements of lean management and digital transformation of the company's investment. In order to achieve the above purpose, based on the construction progress, through the research on the differences of investment plan and investment budget, combined with the cost entry laws of different milestone stages, and considering the lag between construction progress and project cost entry, this subject has formed a set of effective investment connection mechanism model tools. Based on the tool application

results and the problems existing in the collaborative management among multiple departments, this topic puts forward relevant management suggestions to assist the investment management decision-making and improve the collaborative management and control of multiple departments.

2 NON COORDINATION OF PLAN MANAGEMENT AMONG MULTIPLE DISCIPLINES

With the deepening of the reform of transmission and distribution electricity price, how to ensure the stability of transmission and distribution electricity price has become the key to the realization of the benefit goal of power grid companies. As one of the key factors affecting the verification of transmission and distribution electricity price, the accuracy of its prediction and process implementation in the next three years will have a significant impact on the level of transmission and distribution electricity price. As the top priority of the company's investment in power grid infrastructure projects, there are still major problems in the matching between the construction progress and the project cost, the basis for investment budget calculation, carry forward or overdue projects, whether to issue the investment plan and the timeliness of material supply plan changes: first, the financial accounting does not match the project progress. The settlement between the construction management unit and the construction unit is not timely. At the same time, due to departmental barriers, the investment plan and investment budget are managed separately, which are not connected and coordinated with each other [1], resulting in the disconnection between the investment plan and budget management, the lack of verification logic for the data and business of each department, and the low overall management efficiency of the investment project, which is not conducive to giving full play to the management effectiveness of the company; Second, the adjustment cycle of the investment plan of new projects is long, resulting in the lack of basis for the preparation of investment budget; Third, it is very easy to form carry forward projects and overdue projects for single projects with small investment, such as interval expansion and transformation, which are implemented and managed by the Ministry of construction; Fourth, meet the commencement conditions. There is no investment plan and no project under ERP, so there is an urgent need for payment, but there is no investment plan; Fifth, the change of material supply plan is not timely or not implemented in place, which will lead to the mismatch between material supply and project construction progress.

3 RESEARCH ON THE CONNECTION MECHANISM BETWEEN INVESTMENT PLAN AND BUDGET

Taking the power grid infrastructure projects of 110 kV and above as the research object, this topic investigates the differences between the investment plan and investment budget of power grid infrastructure projects in management process, management granularity and preparation methods, and analyzes the occurrence law of various costs in each stage of project construction, with the characteristics of timely and orderly distribution proportion. According to the synergy and characteristics of the above two, based on the actual construction progress and combined with the quantitative relationship between investment plan and investment budget, this paper

constructs the collaborative control preparation and adjustment model of investment plan and investment budget. According to the research problems and the application results of model tools, put forward collaborative management suggestions for different disciplines, assist in the collaborative arrangement of different milestone stages of investment plan and investment budget, and promote the collaborative management among disciplines.



Fig.1 Overall research framework

3.1 Difference between investment plan and investment budget

In order to deeply study the inconsistency between the investment plan, investment budget and construction progress of power grid infrastructure projects, based on the research on the differences between the investment plan and investment budget of the following 110 kV and above power grid infrastructure projects in management process, management granularity and preparation methods, as well as the non synergy between the above two, combined with the cost entry law, this paper constructs the collaborative control preparation and adjustment model of investment plan and investment budget. According to the application results of the model, the collaborative management between investment plan and investment budget is deeply studied. The synergy between investment plan and investment budget is as follows:

Difference	Classification	Investment plan	Investment budget
Management process	Preparation and adjustment time point	The investment plan preparation time node is generally organized in the middle of August. The investment plan report is prepared in the middle and late September and submitted for review according to the requirements of the provincial company. The adjustment time node is basically in accordance with the requirements of the provincial company, and is generally adjusted at the middle and end of the year.	The investment budget is prepared according to the principle of "one up and one down, two up and two down". The time is in October, November and February of the next year. The mid year budget is adjusted around October of the current year, and the adjustment range shall not exceed 15% of the annual budget.
	Specific division of labor at different levels	The development planning department shall organize the construction department to prepare the investment plan according to the Milestone Schedule and the investment statistics rules.	The finance department shall organize the construction department to prepare the financial budget according to the Milestone Schedule and the law of financial expenditure rules.
Management granularity	Compilation fitness	The investment plan shall be prepared according to "milestone monomer project".	The preparation details of the total investment budget are summarized from the individual level and prepared according to the expense details; The annual investment budget is based on the annual investment plan and the remaining available amount of the total investment budget.
	Details of four expenses	The investment plan is based on the predicted progress of each single milestone and combined with the project estimation (budget estimate) to calculate four expenses. It is expected that the single investment will be completed and summarized to the project level.	According to the general principle that the incurred and expected investment budget of each project shall not exceed the project investment plan, the preparation details of the total investment budget are summarized from the individual level and prepared according to the cost details. The annual investment budget is generally prepared directly from the project level (power transmission and transformation project).
	Executive control	Investment plan control is generally managed according to single project.	The total investment budget shall be controlled according to individual and detailed expenses; The annual investment budget is managed according to the level of power transmission and transformation project.
Compilation method	Preparation basis	Preparation basis of total investment plan: feasibility study estimate / preliminary design estimate and balance rate; The annual investment plan is prepared based on the construction progress.	The overall investment budget is prepared according to the feasibility study estimate / preliminary design estimate and the standard cost system to calculate the internal control coefficient; The annual investment budget is prepared based on the construction progress.
	Occurrence law of four expenses and detailed expenses	During the period from commencement to production	Occurs throughout the project life cycle

Fig.2 Difference between investment plan and investment budget

3.2 Build the connection mechanism model between investment plan and budget

Combined with the detailed cost type and proportion law of the recorded cost in the whole life cycle of the project, realize the advance prediction of the milestone nodes in the whole life cycle of the project level, single milestone nodes and material key milestone nodes, and carry out the project image progress prediction in the project construction stage according to "divisional works - key milestone nodes - project level". Based on the above construction progress prediction, considering the law of construction period and the law of cost entry in different milestone stages of the project or single item, distinguish four expenses, and build the connection mechanism model between investment plan and investment budget in combination with the lag law of construction progress and project cost entry.

3.2.1 Determine investment plan and investment budget rules

The milestone stage of the investment plan is from commencement to production. Combined with the law of investment collection value and according to the law of different milestone stages of the four expenses of the single project, the monthly allocation rules of the four

expenses and their detailed expenses during the construction period are set, which are divided into three categories: one-time full allocation at the commencement time point or production time point, monthly average allocation and completion percentage. According to the above rules, the investment plan prediction rules are determined. The investment plan forecast rules are as follows:

Expense details	Substation engineering		Overhead line engineering		Cable line engineering		Intra stage allocation principle
	Scheduled start time	Planned completion time	Scheduled start time	Planned completion time	Scheduled start time	Planned completion time	
1. Other expenses							
Construction site requisition and cleaning fee	--	Project commencement	--	Project commencement	--	Project commencement	One time full allocation
Project supervision fee	Project commencement	Project put into operation	Project commencement	Project put into operation			Average monthly allocation
Preliminary work cost of the project	--	Project commencement	--	Project commencement	--	Project commencement	One time full allocation
Survey and design fee	--	Project commencement	--	Project commencement	--	Project commencement	One time full allocation
Others	Project commencement	Project put into operation	Project commencement	Project put into operation	Project commencement	Project put into operation	Average monthly allocation
Loan interest during construction	Project commencement	Project put into operation	Project commencement	Project put into operation	Project commencement	Project put into operation	Average monthly allocation
2. Construction cost	civil engineering	civil engineering	--	--	Foundation construction (cable channel)	Foundation construction (cable channel)	Apportionment by percentage of completion
3. Equipment purchase cost	--	--	--	--	--	--	One time full allocation
Cable	---	---	---	---	---	Start of cable laying	One time full allocation
Cable accessories	---	---	---	---	---	Installation of cable accessories begins	One time full allocation
4. Installation cost	--	--	Foundation construction (cable channel)	Stringing (cable commissioning)	Tower group (cable laying)	Wire (cable debugging)	Apportionment by percentage of completion
(1) Installation cost (including installation materials)	electrical engineering	electrical engineering	--	--	Tower group (cable laying)	Tower group (cable laying)	Apportionment by percentage of completion
(2) Whole station commissioning	debugging	debugging	--	--	Wire (cable debugging)	Wire (cable debugging)	Apportionment by percentage of completion

Fig.3 Investment plan forecast rules

Investment budget milestones span the whole life cycle of the project. Combined with the accounting law of financial funds, according to the business law of project cost accounting in different milestone stages and the accounting progress law of single project in different construction stages during construction, the monthly allocation rules in the whole process cycle of the project are set according to the four expenses. The allocation rules are divided into four categories: one-time calculation in stages, average allocation by month, average allocation by quarter and allocation by completion percentage. The investment budget prediction rules are sorted out according to different milestone stages. Among them, when predicting the investment budget, the expenses incurred before the commencement are included at the commencement time and calculated together with the entry progress during the construction period [2]. The investment budget forecast rules are as follows:

Expense details	Intra stage allocation principle	Recording progress			Calculation rules
		Constr uction period	Period from production to settlement	Period from settlement to final settlement	
1. Other expenses	Stability, and distribution of monthly				
Construction site requisition and cleaning fee	Phased lump sum	96%	4%	0%	Access by stages at the time of commencement, production and final settlement
Project supervision fee	Average monthly allocation	64%	40%	0%	The construction period and the period from production to settlement shall be apportioned on a monthly basis
Preliminary work cost of the project	Phased lump sum	70%	30%	0%	Access by stages at the time of commencement, production and final settlement
Survey and design fee	Phased lump sum	60%	40%	0%	Access by stages at the time of commencement, production and final settlement
Others	Average monthly allocation	31%	65%	4%	The construction period and the period from production to settlement shall be apportioned monthly, and the final settlement time point shall be included in the remaining 10%
Loan interest during construction	Quarterly average allocation	80%	20%	0%	The construction period shall be apportioned quarterly, and the remaining 20% shall be included in the settlement time point
Production preparation cost	Average monthly allocation	60%	40%	0%	The construction period and the period from production to settlement shall be apportioned on a monthly basis
Project legal person management fee	Average monthly allocation	50%	50%	0%	The construction period and the period from production to settlement shall be apportioned on a monthly basis
2. Construction cost	Apportionment by percentage of completion	90%	10%	0%	he construction period is calculated as a percentage of the construction period, and the settlement time point is included in the remaining 10%
3. Equipment purchase cost	One time full allocation				The arrival time of materials updated according to the material milestone shall be counted in one time
4. Installation cost	Apportionment by percentage of completion	90%	10%	0%	
(1) Installation fee	Apportionment by percentage of completion	90%	10%	0%	During the construction of substation project, it is calculated according to the percentage of completion progress, and the settlement time point is included in the remaining 10%
(2) Commissioning fee (in cable line engineering, cable test and commissioning fee)	Apportionment by percentage of completion	90%	10%	0%	During the construction of overhead line project, it shall be calculated according to the percentage of completion progress, and the settlement time point shall be included in the remaining 10%

Fig.4 Investment budget forecast rules

3.2.2 Build a compilation model of investment connection mechanism for new projects

According to the analysis of the schedule rule, consider the impact of the project construction period, procurement batches, material delivery cycle, etc. on the project's inverted milestones, distinguish between centralized procurement and agreed inventory, and invert the milestone plan. Based on the milestone plan, the construction progress is predicted in the order of "milestone layer-single item layer-project layer", and the construction progress of each month is measured according to the law of construction period. According to the investment plan and investment budget forecasting rules, combined with the construction schedule model, and considering the deviation between the entry and the actual construction schedule, construct a new project investment linkage mechanism compilation model. Take the investment budget forecast of the power transformation project of the newly opened project as an example.

Table 1 Logic of Substation Project Investment Budget Forecast

Expense category	Prediction logic
Construction cost	Predicted civil construction progress * construction cost (total investment budget) * recorded progress during construction; Complete the remaining investment budget at the settlement time.

Expense category	Prediction logic
Installation cost	Predicted overall progress of substation * installation cost (total investment budget) * recorded progress during construction; Complete the remaining investment budget at the settlement time.
Equipment purchase cost	The main equipment can be distinguished. Combined with the predicted time of material key nodes, according to the predicted arrival time of main equipment, it is classified into the investment budget according to the equipment purchase cost (total investment budget).
Other expenses	The investment budget of other expenses is obtained by multiplying the budgetary estimate / feasibility study (detailed expenses of other expenses) by the internal control coefficient; Considering the monthly entry rules of detailed expenses such as construction site requisition and cleaning expenses and project supervision expenses in different milestone stages, the investment budget of each detailed expense is predicted according to the rules of monthly allocation, quarterly allocation or phased one-time inclusion between planned commencement and final settlement.

3.2.3 Constructing the adjustment model of investment linkage mechanism for continued construction projects

According to the actual construction progress of the sub-projects, the minimum safe construction period parameters and the implementation of key nodes in the material chain, the rolling update forecasts the construction progress. Based on the construction schedule, the whole construction period of the project is divided into a historical period and a forecast period. The interval that has occurred in the history is directly replaced and updated with the actual monthly construction progress; the remaining forecast period is based on the rolling update construction schedule plan and the law of the construction period to carry out the construction progress forecast update for the remaining period. Considering the accounting rules of the four project costs at different milestones and the cost accounting rules of the individual construction phases, combined with the lag law between the actual construction progress and the accounting progress, construct an investment coordination management and control coordination adjustment model. Take the rolling forecast logic of the investment budget during the remaining period of the substation project as an example.

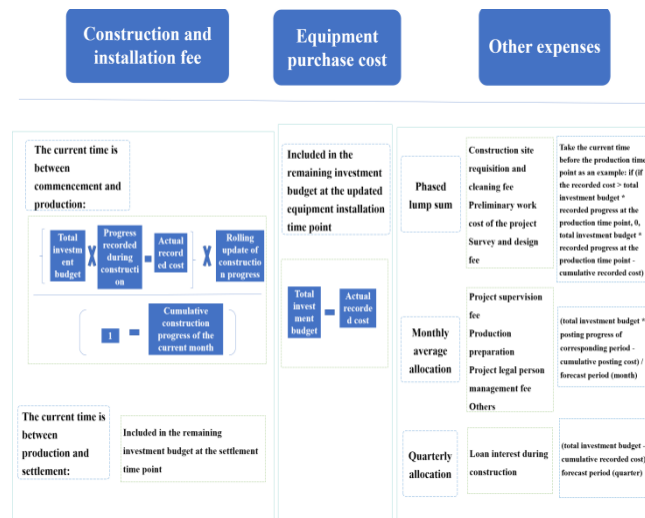


Fig.5 Logic of rolling forecast of investment budget during the remaining period of substation project

3.3 Empirical analysis

Based on the business rules and quantitative relationships between investment plans, investment budgets, and construction progress, this research builds a model of the linkage mechanism between investment plans and budgets. The following is an empirical analysis of the model tools. A certain power transmission and transformation project of the power grid infrastructure was selected for verification. The estimated approved estimate for the project is 17.19 million yuan, a cumulative investment plan of 165 million yuan has been issued, and a cumulative investment budget of 126.42 million yuan has been issued. The actual start time is June 2018, and the actual production start time is July 2019. The specific empirical analysis is as follows:

3.3.1 Example of the preparation model of the investment connection mechanism for newly opened projects

Verification of the annual investment plan preparation model for newly opened projects: The forecast annual investment plan for 2019 is 12.041 million yuan. In order to verify the relative rationality of the results, the cost entry at the end of 2019 was 115.94 million yuan, which was 127.53 million yuan after restoring at a comprehensive tax rate of 10%. The deviation of the model calculation result from it was 7.12 million yuan, accounting for 5% of the approved estimate. After verification and analysis, the model estimates that the project's annual investment plan has a relatively small cost deviation from the tax rate reduction, and the model's calculation results are relatively reasonable.

Verification of the annual investment budget preparation model for newly opened projects: The cumulative investment budget for 2019 is predicted to be 111.96 million yuan. In order to verify the relative rationality of the results, it can be compared with the accumulated investment budget of 110.78 million yuan. The model calculation result and its deviation are 1.18 million yuan, accounting for 2% of the approved budget. After verification and analysis, the deviation between the predicted investment budget and the issued investment budget is small . The

forecasted investment budgets of substation and overhead line projects in 2019 and the accumulated investment budgets are compared with the cost entry respectively. After verification, the predicted investment budget of the model is closer to the entry cost, and the model calculation results are relatively reasonable.

3.3.2 Example of adjustment model of investment linkage mechanism for continued construction projects

Verification of the mid-year investment plan adjustment model: The project was started in 2018, and the estimated annual investment plan is 120.41 million yuan. Since the predicted value does not deviate much from the number of financial entries at the end of the year, and compared with the annual investment plan of 125 million yuan, the deviation is smaller and within an acceptable range, so the calculation results of the adjustment model are relatively reasonable.

Verification of the mid-year investment budget adjustment model: The project was started in 2018. The cumulative investment budget for 2019 is predicted to be 111.96 million yuan, and the cumulative investment budget for 2019 is 110.78 million yuan. Comparing the predicted value and the issued value with the accumulated cost of 115.94 million yuan at the end of 2019, the predicted value of the difference model is closer to the cost and within an acceptable range, so the calculation result of the adjustment model is relatively reasonable. The next step is to strengthen its application, and the sample can be further expanded to provide further guarantee for the relative accuracy of the model's calculation results.

4 MODEL APPLICATION SCENARIOS

Through research on the linkage mechanism of investment plans and investment budgets, a set of measurement tools for collaborative management and control models of investment plans and investment budgets has been formed to promote data transparency among various departments, and realize source collection and full-process sharing [3]. Based on this, the efficiency of coordinated management and control of various departments such as the Infrastructure Department, the Development Policy Department, the Materials Department and the Finance Department has been improved [4]. Based on the verification of the current investment collaborative management and control model tool, the following application scenarios are proposed for different milestones.

(1) The model is used in the planning stage. One is that the project management department sorts out the projects that need feasibility study review every month, and submits them to the relevant competent authorities for review and includes them in the project reserve in a timely manner. Second, after the power grid planning adjusts the plan according to the construction situation, it is issued to the Ministry of Development and Strategy in a timely manner to avoid the situation that the project has no investment plan and cannot pay funds. The third is that the Development Planning Department timely issued the adjustment results to the Construction Department and the Finance Department. Based on the adjusted investment plan and actual construction progress, the Finance Department will make timely adjustments to the investment budget of each project in the current year, taking into account the deviation between the entry and the actual progress, and try to avoid carryover and overdue projects.

(2) The model is used in the construction phase of the project [5]. First, the basic management unit of the Ministry of Construction reports the construction progress in a timely manner every month to ensure that the accounting progress matches the construction progress. Second, the Development Planning Department conducts dynamic monitoring and management of the entire process based on project life cycle management, and supervises the project management unit to update data on time. The third is that the Finance Department pays funds in a timely manner based on the actual construction progress, according to contracts, invoices, etc., to ensure that the accounting progress matches the construction progress, and to ensure the coordination of industry and finance. Fourth, the material department should promptly change the material supply plan according to the project construction situation and implement it in place to match the material supply with the project construction schedule. Fifth, the dispatching profession actively responds to the power outage demand of the construction profession in accordance with the construction situation of the project, so that the project can be inspected and put into production in a timely manner.

(3) The model is used in the final account transfer phase. First, the Finance Department organizes the acceptance work in a timely manner and completes the cost settlement. According to the relevant methods for the final accounts of the power grid infrastructure projects, the final accounts should be completed within 3-6 months after commissioning, and the assets should be transferred in a timely manner. Second, the Ministry of Construction and the Ministry of Finance separately manage the expansion and renovation projects of the bay. Among them, the Ministry of Construction reports the construction status of such projects in a timely manner, and the Finance Department makes timely payment of funds based on the construction status provided by the project management department, effectively shortening the project duration.

5 CONCLUSION

Based on the research on the connection between investment plans and investment budgets, according to the problem of incoordination between investment plans and management, the construction progress is used as the basis for estimation, combined with investment plans and investment budget forecasting rules, to construct an investment plan and budget connection mechanism model. Through research on the linkage mechanism of investment plans and investment budgets, a set of measurement tools for the collaborative management and control model of investment plans and investment budgets has been formed, which promotes data transparency among various departments, realizes source collection and whole-process sharing, and realizes coordinated management of various departments.

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