Relationship between Utility Tunnel Admission Fee and Power Grid Company Economic Benefit based on Life Cycle Costs Management

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Abstract—**In order to take advantage of urban underground space, the government introduced so many policies to encourage utility tunnel development. However, compensated use also increased the operating expenses of the Power Grid Company. Based on the principle of "safety, reliability and economy", this paper took business cost, electricity income, government subsidies and other related factors into account and assessed the impacts of different admission fees in 3 kinds of situations to Power Grid Company. Meanwhile providing constructive suggestions in payment method and government share by evaluating the Power Grid Company economic benefit from IRR, NPV and payback-period.**

Keywords—utility tunnel; admission fee; life cycle costs; economic benefit; payment method; government share

I. INTRODUCTION

Utility Tunnel has great comprehensive benefits like making good use of underground space, reducing the frequency of road excavation and traffic congestion, as well as improving the urban environment. In order to speed up infrastructure construction in underground space, the government introduces lots encouragement-policies of a utility tunnel. The utility tunnel includes kinds of pipes of electricity, communications, radio, television, heat, gas and water supply and drainage. According to the policy, within the scope of utility tunnel, electricity cable has to lay in it. The policy also demands the compensated use of Utility Tunnel, thus the power grid company needs to offer the admission and daily-maintenance fee. Though the fees will increase power grid company's operating express, as one of the most important measures to promote urban infrastructure construction, power grid company should actively advance electricity cable into the pipe[1]-[6]. To ensure the company's economic benefit, we have to calculate admission fee from technology, planning and economy. This paper only analyses economic benefit of 220kV electricity cable admission fee, striving for providing constructive suggestions.

II. CHARGE STANDARDS

This paper gathered 6 cities' charge policy, namely Hefei, Wuhan, Suzhou, Yinchuan, Chengdu, Xiamen. Among them, Hefei and Wuhan only specify the charge and calculation principle instead of standard details; While Suzhou, Yinchuan, Chengdu, Xiamen, these four cities, released specific charge standard with big differences in the amount, demand or preference terms. Differences are specified as follows [7]-[15].

- Suzhou. This city introduced the Utility Tunnel Charge Standard in Urban Underground Space which stipulated that the charges include admission and daily-maintenance fee. Meanwhile, the admission fee is one-time full charge without fluctuation. If Party B wants to pay this fee by installments, the financial expenses should be negotiated; the standard of daily-maintenance fee should be developed in line with the maintenance cost of the tunnel and its affiliated facilities, related tax, rational profit and the space proportion, with fluctuation between -20% to 20%.

- Yinchuan. this city introduced the charge standard also includes the admission and daily -maintenance fee. But the amount of admission fee is based on the cost of laying pipelines repeatedly in 100 years; the daily-maintenance fee is according to the cost of the tunnel and its affiliated facilities and normal management fee of operating company, shared by space proportion.

- Chengdu. The payment method of admission fee is optional, Party B can choose to pay by instalments, in one-time full charge or two-time half charge. And the payment in one-time full charge or two-time half charge is with the discount of 20% or 10% separately.

The standard of daily-maintenance fee has 3 kind, namely big line, middle line and small line, the amount is different according to the pipeline's kind.

TABLE I. UTILITY TUNNEL CHARGE STANDARD AMONG 4 CITIES

	Admission Fee 10000yuan/km`rope`year	*Daily-Maintenance Fee wanyuan/km`rope`year*
Suzhou	1.9	1.1
Yinchuan	0.3091	1.659
Chengdu	0.3517	0.38
Xiamen	0.9603	1.821
Average value	0.8803	1.24

TABLE II. UTILITY TUNNEL MEASURED PARAMETERS

	unit	*value*
Operation Period	year	100
Installation fee	10,000 yuan/km`pipe	369.23
Rate of maintenance cost	%	5%
Residual value of depreciation	%	5%
Depreciation period	year	30
Long-term loan interest rate	%	4.90%
Short-term loan interest rate	%	4.35%
VAT rate	%	13%
Income tax	%	25%
Utility daily-maintenance fee	Ten thousand yuan	1.24

- Xiamen. The charge standard is in the trial period, and after the government pricing procedures, the fee will be made up under the basis of the formal standard.

After uniting the standards, the admission fee and daily-maintenance fee among different cities are shown in Table I.

III. ADMISSION FEE MEASUREMENT

This paper collected 220kV power grid cable project completed from Jan.1st 2006 to Dec.31st 2018 as sample, considering business cost, electricity income, government subsidies and other related factors to measure the admission fee offered by Power Grid company. Meanwhile on Life Cycle Cost Management, analyze and estimate economic benefit from NPV, IRR and pay-back period, and provide constructive suggestions for Power Grid Company from the angle of yield rate. The economic benefit is related to the hurdle rate, payment method, and government subsidies. In the measurement, this paper selected 4.27% (equal to five-year treasury bond yield), 5% (equal to electricity income yield), 5.5% (equal to central enterprises performance assessment index) as the hurdle rate, to calculate:

- Without government subsidies, in different hurdle rate, the admission fee of one-time full charge;

- Without government subsidies, in one hurdle rate, the admission fee of paying by installments;

- With different government subsidies, in one hurdle rate, the admission fee of one-time full charge.

A. Measure method

IRR is the hurdle rate when the financial net present value is 0. Use formula as follow, we can work out the IRR.

$$NPV = \sum_{t=0}^{n} \frac{(CI - CO)_t}{(1 + IRR)^t} = 0 \qquad （1）$$

NPV is the present value discounted by hurdle rate or given ratio. Use formula as follow, we can work out the NPV.

$$NPV = \sum_{t=0}^{n} \frac{(CI - CO)_t}{(1 + i_c)^t} \qquad （2）$$

The payback period is the time investment be recovered. Use formula as follow, we can work out the payback period.

$$\sum_{t=0}^{P_t} (CI - CO)_t = 0 \qquad （3）$$

In the formula, CI is the cash inflow, CO is the cash outflow, t is the year, n is the calculation period.

B. Measured parameters

This paper took the Power Grid Company as the benefiting entity. Under the *General Cost of Power Grid Transmission and transformation Project*, the technical life of single 220kV cable is 40 years. Accordingly, on the Life Cycle Cost Management, this paper measured the total cost and revenue of 220kV cable which laying in the tunnel during 40 years and worked out related economic index.[2]

- Cash Outflow. Including cable installation fee, main equipment and materials purchase cost, operation and maintenance cost, financial expenses, related taxes, utility tunnel admission fee and daily-maintenance fee. Among these costs, the daily-maintenance fee of the utility tunnel took the average value of 4 cities above.

- Cash Inflow. Including the main electricity income and other related revenues. Among them the electricity income belongs to cable laying in the tunnel could not be separated from the province's one, we took the overall electricity income to measure the benefit index.

The specific paraments are shown in Table II.

C. Measure Result

Since the social value of utility tunnel is greater than the economic one, this paper took 0% as one hurdle rate to measure the upper limit of admission fee, that is when the Power Grid Company supporting government infrastructure constriction without any return; at the same time, the five-year treasury bond yield of 4.27%, the comprehensive income of the provincial grid transmission and distribution price calculation

of 5%, and the central enterprise responsible person assessment investment return rate index of 5.5% were taken as the base rate of return. Substitute the relevant parameters into formulas to obtain the cable admission fees in different situations. Details are shown as follows.
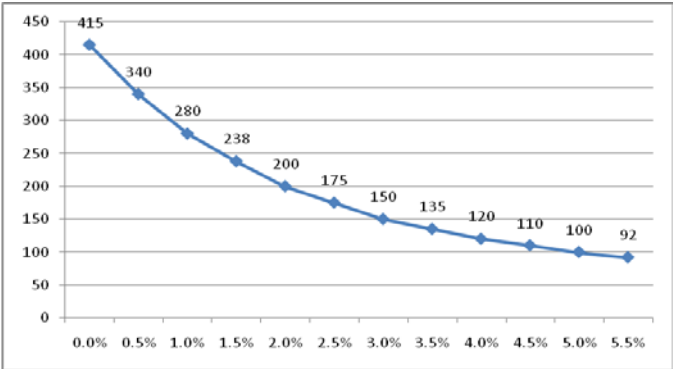

Fig. 1. The variation trend between admission fee and base rate

TABLE III. ECONOMIC BENEFIT INDEX OF ONE-TIME FULL CHARGED UTILITY TUNNEL ADMISSION FEE

Base Rate	unit	0%	4.27%	5%	5.5%
Admission Fee	million yuan /km·rope	4.15	1.15	1.00	0.92
IRR	%	0.13%	4.30%	5.08%	5.59%
NPV	million yuan	-2.87	0.0064	0.15	0.23

TABLE IV. ECONOMIC BENEFIT INDEX OF UTILITY TUNNEL ADMISSION FEE PAID BY INSTALLMENT

Base Rate	unit	0%	4.27%	5%	5.5%
Admission Fee	10 thousand yuan/km·rope	4.41	4.81	4.86	4.89
IRR	%	0.05%	4.27%	5.00%	5.52%
NPV	million yuan	9.23	0.06	1.15	1.84

1) One-time full charge of utility tunnel admission fee.

The fee paid one-time full charged of single-kilometer 220kV cable is inversely proportional to the base rate of return. And generally shows an exponential downward trend (Fig. 1) , with the base rate increase, the acceptable admission fee of the Power Grid Company is declined gradually slowly.

Under normal circumstances, the designed service life of the utility tunnel is 100 years, and the one-time full charge admission fee is the cost of using the tunnel for 100 years. From Table III, when the Power Grid Company doesn't require investment return, that is the benchmark return rate is 0%, the upper limit of the admission fee of single 220kV cable is 4.15 million yuan/km, and the internal rate of return is 0.54%, the NPV is -2.87 million yuan /km·rope; when the company requires 4.27% of five-year treasury bond yield, the acceptable upper admission fee of single 220kV cable declined to 1.15 million yuan/km, and the IRR is 4.30%, the NPV is almost 0; similarly, when the company asks for 5% of the electricity

price revenue, the upper admission fee is 1 million yuan/km·rope ; when it demands 5.5% of the assessment income index, the fee decreased to 0.92 million yuan/km·rope.

TABLE V. THE GOVERNMENT ALLOCATION PROPORTION IN DIFFERENT CONSTRUCTION COSTS, BASE RATE, AND ADMISSION FEE

| Base rate	0.0%	4.0%	4.5%	5.0%	5.5%
Admission fee	415	120	110	100	92
Government Proportion of 1 million construction cost	0%	0%	0%	0%	8%
Government Proportion of 2 million construction cost	0%	40%	45%	50%	54%
Government Proportion of 3 million construction cost	0%	60%	63%	67%	69%
Government Proportion of 4 million construction cost	0%	70%	73%	75%	77%
Government Proportion of 5 million construction cost	17%	76%	78%	80%	82%
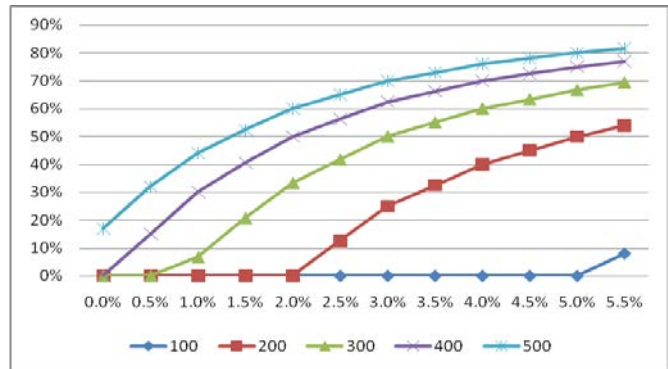
Fig. 2. The government allocation proportion in different construction costs, base rate and admission fee

2) The admission fee paid by installments.

It can be learned from Table IV that, after calculation, the Power Grid Company only needs to pay around 50000 yuan/year, no matter in which base rate. Due to the currency time value, the annual payment of utility tunnel admission fee greatly reduces the company's operating expense and releases the company's cashflow pressure. The specific benefit index is shown in Table III.

3) The admission fee of one-time full charged with different government subsidies.

On one hand, from the perspective of "who benefits and who shares", the government should share the construction costs of the utility tunnel; on the other hand, when the admission fee of one-time full charged is adopted, assumed that the government can carry forward the cost sharing in the end of the year, the behavior is similar to in-kind financing and the relevant interest should be paid to payers. Meanwhile, the admission fee higher, the commitment proportion is higher. Since there are so many different types of utility tunnel and the construction cost is uncertain, the undertaken proportion of the Power Grid Company in each project should be different. Here, we only provide the calculation based on above admission fee

of one-time full charged measurement, to back-calculate the proportion of the government's allocation of single-kilometer 220kV cable costs. Assuming that the government's construction cost belongs to 220kV electricity cable is 5million yuan/km·rope, at a base rate of 0.5%, the admission fee is 3.4 million yuan/km·rope, besides the government should share 32% of construction cost. All other detailed situations are shown in Table V and Fig. 2.

IV. CONCLUSION AND SUGGESTIONS

From the above analysis, we can conclude as follow from the Life Cycle Cost Management perspective.

- Without government subsidies, under different benchmark yields, the upper admission fee of Power Grid Company accepted is 1.15 million yuan/km·rope in 4.27% 5-year treasury bond yield, 1 million yuan/km·rope in 5% electricity price income rate, and 0.92 million yuan/km·rope in 5.50% assessment index.

- In the absence of government subsidies, in the same base rate, the Power Grid Company only needs to burden 0.05 million yuan/km·rope for 220kV cable admission paid by installments, which releases the cashflow pressure to the company.

- The proportion of government allocation is related to the construction cost of the tunnel and the base rate of the Power Grid Company. In the same construction costs, the higher base rate asks for higher allocation proportion; in the same base rate, the higher construction costs need higher proportion too.

Therefore, it is recommended that when negotiating with the government, the Power Grid Company should select to pay by installments with less cashflow pressure, and then struggles for government subsidies, the higher the better.

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