Construction specification fulfilment cost accounting

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Abstract. In this article, we considered and analyzed costs of fulfilling specifications regarding connection to technical building systems and shared utilities. Such calculations for the construction cost estimate documentation at the pre-investment stage pose difficulties associated with determining the connection specification costs. To resolve this issue, we analyzed costs of fulfilling specifications regarding connection of representative housing structures to technical building systems in Irkutsk. We used the cost estimate documentation of actual housing projects in Irkutsk as the baseline data for the analysis. As a result, we determined the percentage amount of specification fulfilment costs in the total construction cost, as well as the recommended percentage amount of specification fulfilment costs per type of connection in the total construction cost. We propose using these ratios for summary cost estimates at the pre-investment stage to optimize housing construction costs.

1. Introduction

The costs of fulfilling specifications regarding connection to technical building systems and shared utilities must be calculated as per the Construction Summary Cost Estimate Schedule of the Russian Federation. These costs are calculated in the first section of a summary cost estimate, "Construction area preparation," and constitute a significant share of the total construction cost. According to some researchers [1,2,3], these costs constitute 15–22% of the construction cost; however, they have been decreasing since 2010 [4,5]. Experts analyzed the experience of technological connection to the power grid and determined the main problems of the Russian consumers resulting in higher construction area preparation costs [6]. By resolving these problems, specification approval costs may be decreased to 12% [7,8].

2. Materials and Methods

We used accounting (financial) reporting data of construction companies from Irkutsk and submittals for the projects under construction in Irkutsk as the informational background of this study.

The methods included economic and statistical analysis, the system approach, and systematization of theoretical and empirical data.

Analysis and optimization of the specification fulfilment costs in the total construction cost is based on the construction cost estimate schedule of the Russian Federation in force during the study period.

3. Results
Technological connection is a service provided by power grid operators to natural and juridical persons to enable electric power consumption (output) and entailing effective connection of power receivers of applicants to grid facilities.

Along with power transmission, technological connection is a separate institutionalized service provided by power grid companies.

The decision to make technological connection a paid service with an investment component was adopted by the government faced with increasing power grid's deficiency impossible to overcome with any other method in the context of power transmission tariff increase restrictions.

Technological connection service tariffs charged by power grid companies are determined by the government bodies authorized to regulate tariffs in a given region and regulated by the decisions made on the executive level. Technological connection is a paid service in the following instances:

1. Connection of the devices commissioned for the first time or previously connected reconstructed devices when the connected capacity is increased;
2. When the power supply reliability category, points of coupling, or type of activity changes as regards the previously connected devices, which does not result in a review of the connected capacity, but modifies the external power supply scheme for these devices.

The technological connection fee charged from a person applying to the regulatory body to enter into an agreement of connection to the centralized systems depends on the current technological connection tariffs.

The connection fee is calculated by the organization that performs technological connection depending on the current technological connection tariffs, the technologically connected capacity increase, and the distance from the coupling (technological connection) point of the applicant's structure to the point of coupling to the centralized systems.

The Tariff Service of the Irkutsk Region and the City of Irkutsk establish the power grid connection tariffs in Irkutsk.

The money charged by utility companies as connection fees is allocated as follows:
- power grid construction from the coupling point of the applicant's structure to the centralized system's facilities (mileage tariff rate);
- reconstruction (modernization) of urban facilities to avoid the transmission capacity being insufficient to satisfy the new customer demands given the residential, public, business, and industrial development of a municipality.

The investment program involves power grid modernization to increase the transmission capacity and use of polymer materials to connect permanent structures.

The main stages of technological connection by type of utilities are described in Table 1.

**Table 1. Main stages of technological connection to utilities.**

| Type of utilities | Stages |
|------------------|--------|
| Power grid       | • Determination of the grid operator  
• Application for technological connection to the grid operator  
• Entry into an agreement with the grid operator  
• Fulfilment of the measures provided by the agreement by the parties thereto  
• Actual connection of the applicant's structures to the power grid  
• Completion of technological connection certificates by the parties to the agreement  
• Entry into a power supply agreement |
| Heat supply system | • Selection of an organization to perform technological connection  
• Application for connection agreement to the organization performing technological connection  
• Provision of connection conditions, entry into a connection agreement  
• Fulfilment of the connection measures provided by the specification and the connection |
Therefore, connection fees constitute one of the financing sources for the investment program aimed at reconstruction and development of the urban facilities.

The connection tariffs include the expenditures of utility companies allocated to both build and modernize the grid/mains/systems to connect new structures.

The construction permit (CP) must be obtained by the land proprietor or their attorney before the structure is designed and built. CPs are drafted and regulated by the Town Planning Code of the Russian Federation. The costs associated with securing the construction permit include power grid connection and connection to the water and wastewater mains and the heat supply system. The connections are performed according to the regional tariff policy and regulated on the federal and regional level.

**Table 2.** The laws regulating calculation and determination of the fee for technological connection to the grid/mains/systems

| Type of utilities | Laws                                                                 | Regional/local                                                                 |
|------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Power grid       | Civil Code of the Russian Federation;                                 | Order No. 448-cnp "On the Standardized Tariff Rates, Maximum Power Unit Rates, Pricing Formula regarding Technological Connection to the Power Grid Operated by Irkutskai Elektrosetevai Kompania OJSC" approved by the Tariff Service of the Irkutsk Region on December 27, 2019 |
|                  | Federal Law No. 35-ФЗ "On the Power Engineering" dated December 29, 2017; | Order No. 448-cnp "On the Standardized Tariff Rates, Maximum Power Unit Rates, Pricing Formula regarding Technological Connection to the Power Grid Operated by Irkutskai Elektrosetevai Kompania OJSC" approved by the Tariff Service of the Irkutsk Region on December 27, 2019 |
|                  | Rules of Technological Connection of Power Receivers of Electricity Consumers, Electricity Generation Facilities, and the Power Grid Facilities Owned by Grid Operators and Other Entities to the Power Grid (approved by Resolution No. 861 of the Government of the Russian Federation dated December 27, 2004); Pricing Principles regarding Regulated Power Supply Prices (Tariffs) (approved by Resolution No. 1178 of the Government of the Russian Federation dated December 29, 2011); Methodological Guideline to Determine the Fee for Technological Connection to the Power Grid (approved by the Order No. 209-1/1 of the Federal Tariff Service of the Russian Federation dated September 11, 2012, as amended on August 01, 2014) | |
| Heat supply system | Federal Law No. 190-ФЗ "On the Heat Supply" dated July 27, 2010, as amended by July 29, 2017; Rules of Connection to Heat Supply Systems (approved by Resolution No. 307 of the Government of the Russian Federation dated April 16, 2012, as amended on September 09, | "On the Implementation of the Heat Supply System Connection Fee in Irkutsk" (Order No. 555-cnp of the Tariff Service of the |
All the aforementioned expenditures must be accounted to determine the total amount of capital expenditures in the summary cost estimate. If the cost estimate documentation is drafted by a contractor at the stage of construction, such a calculation poses no difficulties. By that time, all the specifications have been received, their costs—determined and may be totalized in the first section of the summary cost estimate. However, at the pre-investment stage, it is virtually impossible to account the cost of specifications in the cost estimate documentation due to the lack of information on connection. This means that the investment amount for these expenditures may be determined either roughly or on the basis of the data on similar projects [9,10,11].

4. Discussion
We analyzed specification expenditures of twelve representative housing structures built in Irkutsk on the basis of the actual cost estimate documentation.

Table 3. Structure of specification expenditures of representative structures in Irkutsk

| Name of Structure | Specification cost, thou RUB | Including | Structure of expenditures, % |
|-------------------|-------------------------------|-----------|------------------------------|
|                   | Cold water supply fee | Wastewater fee | Heat supply system connection fee | Power grid connection fee | Cold water supply fee | Wastewater fee | Heat supply system connection fee | Power grid connection fee |
| Emerald Housing Estate | 33,583.6 | 6 | 5896.8 | 4762.98 | 21,675.5 | 1248.32 | 17.56 | 14.18 | 64.54 | 3.72 |
| Alma Mater | 36,544.8 | 9 | 5752.1 | 4738.34 | 24,600.5 | 1453.82 | 15.74 | 12.97 | 67.32 | 3.98 |
| Housing Estate | 30,883.0 | 6840.0 | 5552.49 | 17,175.3 | 1315.11 | 22.15 | 17.98 | 55.61 | 4.26 |
|----------------|----------|--------|---------|-----------|---------|-------|-------|-------|-----|
| 4. Duo Housing Estate | 59,763.2 | 26,839 | 5118.11 | 26,233.0 | 1572.32 | 44.91 | 8.56 | 43.89 | 2.63 |
| 5. Rainbow Housing Estate | 21,255.0 | 3910.9 | 2168.01 | 14,368.3 | 807.69 | 18.40 | 10.20 | 67.60 | 3.80 |
| 6. Dalnevostochnaia Street Housing Estate | 37,324.0 | 6046.4 | 4814.80 | 24,868.9 | 1593.73 | 16.20 | 12.90 | 66.63 | 4.27 |
| 7. Residential building in Bagrationa Ulitsa | 13,295.1 | 2752.1 | 2233.59 | 7631.43 | 678.05 | 20.70 | 16.80 | 57.40 | 5.10 |
| 7. Residential building in Afanaseva Ulitsa | 12,563.2 | 2801.6 | 1984.99 | 6193.66 | 1582.96 | 22.30 | 15.80 | 49.30 | 12.60 |
| 7. Residential building in Profsoiuznaia Ulitsa | 10,117.8 | 1811.1 | 930.84 | 4897.04 | 2478.87 | 17.90 | 9.20 | 48.40 | 24.50 |
| 7. Residential building in Radishcheva Ulitsa | 13,295.1 | 3230.7 | 2459.61 | 6634.29 | 970.55 | 24.30 | 18.50 | 49.90 | 7.30 |
| 11. Dekabrskikh Sobytii Street Housing Estate | 14,268.9 | 2397.1 | 1954.84 | 9017.94 | 898.94 | 16.80 | 13.70 | 63.20 | 6.30 |
| 7. Residential building in Trilissera Ulitsa | 7294.90 | 1553.8 | 1057.76 | 3924.66 | 758.67 | 21.30 | 14.50 | 53.80 | 10.40 |

In Table 3, we see that the heat supply system connection fee is the highest of all the specification costs—57.3% of the total specification fulfilment costs on the average [12,13].
Figure 1. Structure of specification costs by types of fees, %

We analyzed fees and how they depend on the total cost of construction of representative structures to roughly determine the specification fulfilment cost at the pre-investment stage.

Figure 2. Specification expenditures / estimated construction cost ratio, %

Based on the conducted analysis [14,15] we may conclude that when justifying the amount of specification expenditures at the pre-investment stage, the specification costs may be assumed to constitute 7.57% of the total cost of the second section of the "General Construction Projects" summary cost estimate.

We analyzed fees by types of connection on the basis of the calculated structure of specification costs.
Figure 3. Structure of cold water supply specification costs, %.

Figure 4. Structure of wastewater specification costs, %.

Figure 5. Structure of heat supply system specification costs, %.

Figure 6. Structure of power grid specification costs, %.
5. Conclusion
We analyzed the preparation period expenditures, namely, specification expenditures by types of connection, to resolve the problem of calculating the project construction cost at the pre-investment stage. Based on the conducted analysis, we recommend assuming the specification costs to constitute 7.57% of the total cost of the second section of the "General Construction Projects" summary cost estimate at the pre-investment stage.

See the recommended amount of specification expenditures by types of connection in Table 4.

Table 4. Recommended amount of specification expenditures by types of connection as a percentage of the construction cost.

| Specification costs as a percentage of the construction cost | Including |
|---------------|-----------|
|               | Cold water supply fee | Wastewater fee | Heat supply system connection fee | Power grid connection fee |
| 7.57%         | 1.63%      | 1.04%          | 4.34%                     | 0.56%                    |

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