Engineering and Technical Support of Territories for Implementation of Renovation Projects of the Housing Stock

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Abstract. This scientific article researches features of preparations for the construction of renovation projects areas on the example of the city of Moscow. The purpose of the article is to examine and study features of preparations for the construction of renovation projects areas, these feature's being one of the factors determining energy efficiency activities application at a construction site. Statistical data compilation method, regulatory documents examination method and method of review, comparison and consolidation of information are used in this paper. In the context of the research engineering equipment provision of housing stock renovation sites is analysed and renovation areas classification based on water, heat and power supply system's provision is provided. As a result of the analysis of five renovation areas, a number of specific features of renovation areas engineering equipment provision are identified. For the most part Moscow renovation areas are divided into two forms: energy-deficient (EP) which lack reserve margins of fuel and power resources; energy-excessive (ER) which have an excess supply of fuel and power resources. Energy-balanced areas (EB) are considered to be of the highest possible level of renovation areas development.

1. Introduction

The problem energy preservation during renovation of built-up areas is complex and covers all stages of the renovation areas development. The existing five-storey apartment blocks are interconnected with the existing system engineering networks and communication which form fuel and energy supply of both the renovation areas and the city of Moscow as a whole. When implementing the renovation process which is a transition from the existing five-story apartment blocks to modern multi-storey apartment blocks there is a problem of fuel and energy balance in all stages of the process, namely: maintenance of the «old» five-story apartment blocks, demolition and new construction, maintenance of modern high-rise apartment blocks. In this regard, the construction process is specific in nature, which should imply the rationing of fuel and energy resources (FER). [1], which allows to regulate energy preservation in the construction industry, increase the efficiency of FER usage and transfer energy consumption in construction organizations to the regulatory framework [1].

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At the development stage of the construction organization project, the main task is to calculate the required capacity of all types of energy consumers to ensure the connection of the construction site to the city engineering networks or local energy sources and their uninterrupted work for the entire construction period. In this case, as a rule, the consumption of FER is not calculated, and the capacity is determined with a margin [2, 3].

When developing a works performed project on the basis of a feasibility studies, organizational and technological decisions affecting the consumption of fuel and energy resources at the construction site, as well as the results of preparation of the construction site, which provide baseline data to interconnect permanent and temporary engineering communications at the construction site are concretized [2, 3].

The problem of energy preservation at a construction site has been under-researched and was examined in various scientific works [2-6], which addressed: general principles and approaches to energy preservation, analysis of various energy consumers at the site, the impact of seasonal and climate impacts on building production, energy preservation at various stages of construction production excluding demolition, and also FER consumption groups were classified, the factors and the degree of their influence on the amount of energy consumption in the construction industry were determined [6]. However, the agenda of these works did not touch upon such specific areas of development as renovation areas, which actualizes scientific research on the issue of energy preservation at the construction site in the renovation process.

2. Materials and Methods

To conduct a research in this article the renovation program of the housing stock in the city of Moscow, the technical specifications for the architectural and urban planning of experimental sites for the renovation of the housing stock in Moscow, as well as the principles of the organization of the construction process during the renovation period were used. We used the methods of systematization of engineering data, the study of regulatory documentation, analysis, comparison and synthesis of information. Construction preparations are regulated by the joint venture 48.13330.2011 «SNiP 12-01-2004. Organization of construction» and STO NOSTROY 2.33.14-2011 «Organization of construction production. General provisions» [7, 8].

The preparatory period of construction is a «physical» implementation of activities at the construction site, envisaged by the organizational period, which includes: off-site and on-site work (site preparation, site engineering preparation, mobile (inventory) complexes construction [8]).

At the preparatory stage of the construction industry it is important to determine the actual location of the places and conditions for connecting temporary engineering communications to permanent networks to provide the construction site with fuel and energy resources such as electricity, water, heat and steam.

A specific feature of the implementation of renovation projects in the city of Moscow in terms of construction site preparations and energy efficient component of the construction process is consideration of the provision of the construction site with engineering networks and the release of the renovated area, namely the demolition and dismantling of the existing five-story building.

For fuel and energy support of power and technological consumers at the construction site, outdoor and indoor lighting of construction objects, utility-auxiliary buildings, areas of execution of construction and engineering work, permanent and temporary networks are used, that is, the rationing of FER depends on rational organizations of temporary construction infrastructure: temporary water supply and temporary energy supply for construction, which are temporary at building sites.

A distinctive feature of the renovated area for demolition and new construction is the existing and functioning fuel and energy support for the apartment block, that is, the existence of trunk and engineering networks and utilities (water, heat, gas and electricity) that form the initial parameters of the engineering conditions of the construction site. The use of permanent engineering networks in conjunction with temporary ones is established by the following parameters:

- energy loads calculation;
- energy sources choice;
- identification of objects of service of the first category (objects requiring backup power that is water decrease, electric heating, boiler rooms, fire pumps, etc.), located in the territory;
- working scheme of electricity supply, heat supply, gas supply and water supply mapping [2, 3].

Table 1. Technical and economic indicators of the renovation area.

Technical and economic indicators	**Golovinsky District**	**Prospect Vernadsky District**	**Kuzminki District**	**Khoroshevo-Mnevniki District**	**Tsaritsyno District**
Plot area, ha	133	126,4	109,65	125,9	106,81
Saved housing area, sqm	522 000	702 580	355 860	713 750	321 320
Existing housing density, sqm/ha	7 600	10 400	9 300	8 400	7 800
Population, people *1-5 fl. housing* *6-12 fl. housing* *13-16 fl. housing* *17+ fl. housing*	26 982 57% 22% 16% 5%	22 129 55% 13% 15% 17%	28 985 64% 26% 1% 9%	26 942 54% 27% 8% 9%	11 190 65% 32% 1% 2%

For the analysis of engineering provision of development sites, five areas of Moscow where renovation projects will be implemented in the future were considered: Golovinsky district, Kuzminki district, Vernadsky Prospect district, Khoroshevo-Mnevniki district and Tsaritsyno district (see figure 1).

Security zones of the main engineering networks and communications are established in accordance with: joint venture 42.13330.2011, MGSN 1.01-99, SanPiN 2.1.4.1110-02, Decree of the Government of Moscow of September 17, 1996 No. 788, joint venture 124. 13330.2012 Thermal networks, joint venture 62.13330 .2011, as well as experiences of operational services [9-13].

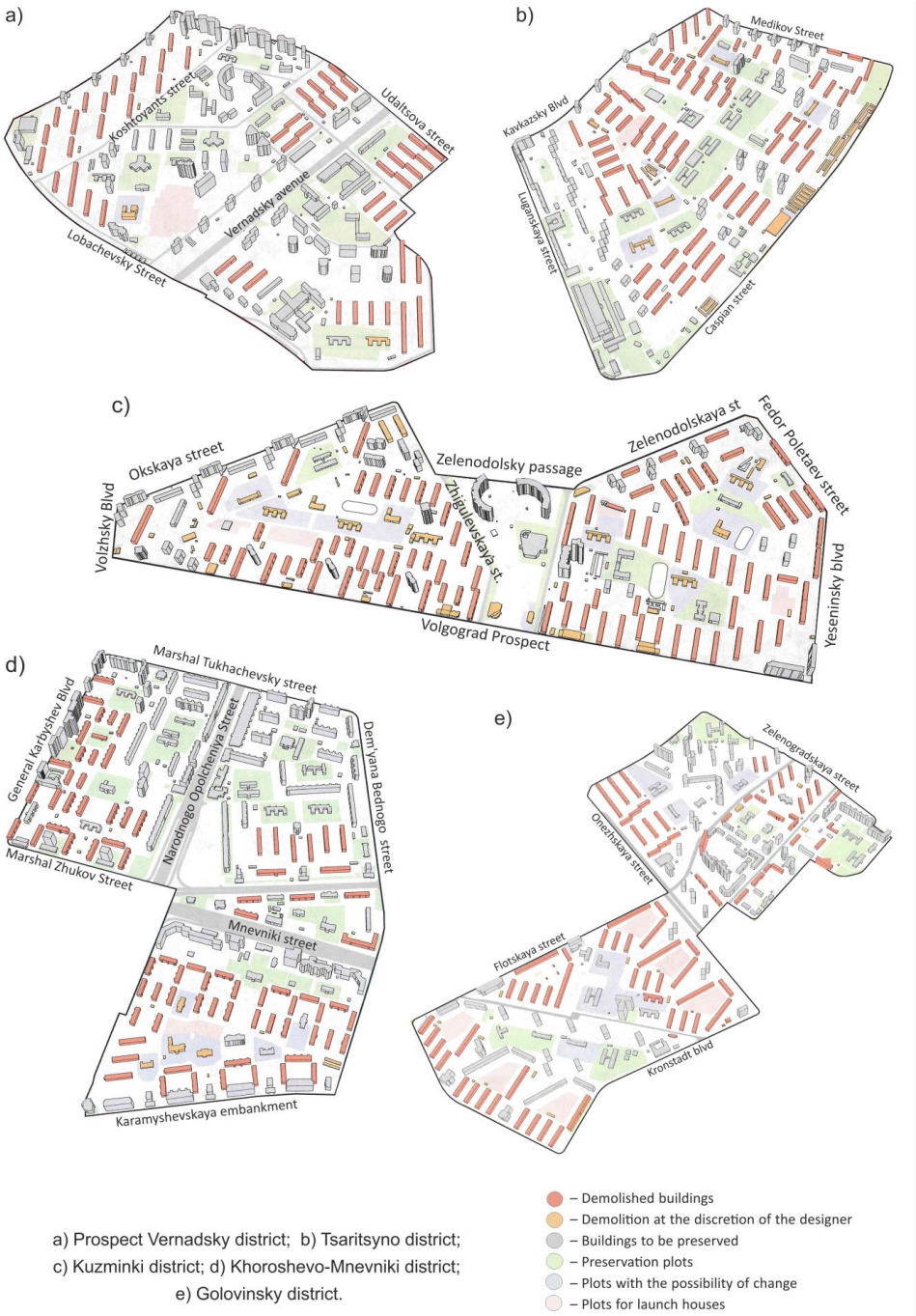

Fig. 1. Renovation projects areas

Table 2. Summarized engineering equipment supply data for renovation projects development sites.

Construction areas	Water supply	Heating supply	Electrical power supply
1. Golovinsky District	The area is located is within the area of affect of the Northern Water Treatment Station (CER). According to the data of JSC Mosvodokanal, as of January 1, 2005, the capacity of the CER amounted to 1.92 million m3 / day, and there is currently a water supply reserve for new consumers. The power sources of the territory under consideration are water conduit CER d = 1200 mm, passing through the intra-quarter territory and along Onezhskaya street, water conduit CER d = 1400 mm and highway d = 900 mm along Flotskaya street [9].	The area is located in the coverage area of CHP 21, which has a capacity reserve. The heating supply of the apartment block is provided by the branches 2d = 900-1000 mm, laid along the Naval street. Consumers are connected to heat networks via heat points (CHP and ITP) [9].	The electrical power supply of the existing apartment block is carried out at a voltage of 6-10 kV from electrical substations 220/110/10/6 kV «Novobratsevo», 110/10/6 kV «Leningradskaya» and «Koptevo» 110/10 / 6kV. SS «Leningradskaya» has a limited technological connection capacity reserve [9].
2. Prospect Vernadsky District	The area is located within the area of affect of the Western Water Treatment Station (ZSV). According to the data of Mosvodokanal JSC, the capacity of the ZSV is 1.7 million m3 / day. There is currently a water supply reserve for new consumers. The source of water supply of the territory in question is: highway d = 1200 mm along Vernadsky Avenue and highway d = 900 mm along st.Lobachevsky [10].	The area is located in the coverage area of CHPP-25, which has a capacity reserve . The heating supply of the building is carried out from the heating main 2d = 1200 mm, laid along Lobachevsky Street. Branches from the heating line 2d = 400 mm, 2d = 500 mm and 2 d = 800 mm pass through the territory of square. 32-33 and 34-35. Consumers are connected to heat networks using heat points (CHP and ITP) [10].	The electrical power supply of the existing apartment block is carried out at a voltage of 10 kV from an electrical substation: 110/10/6 kV Lomonosovo substation and 110/10 kV Vernadskaya substation [10].
3. Kuzminki District	The area is located within the area of affect of the Eastern Water Treatment Station. According to the data of JSC Mosvodokanal, the capacity of the BCA is 1.4 million m3 / day. There is a water supply reserve for new consumers. Water supply is carried out through Kuzminsky regulating unit (RU). Sources of water supply of the territory in question are: the water lines VSV 2d = 1400 mm along Volzhsky Boulevard, d = 1200 mm along Okskaya Street and the highway d = 900 mm,	The area is located in the coverage area of CHP-22, which has a capacity reserve. The heating supply of the building is carried out by branches 2d = 150-700 mm from the heating main 2d = 1200 mm, which is laid along Zhigulevskaya Street. Consumers are connected to heat networks through heat points (CHP and ITP) [11].	The electrical power supply of the existing apartment block is carried out at a voltage of 10 kV from electrical substations: 110/10/6 kV Vykhino PS and 110/10 kV Chukhlinka PS, Chukhlinka PS has a limited power reserve for technological connection [11].

	passing from Zelenodolskaya Street [11].		
4. Khoroshevo-Mnevniki District	The area is located within the area of affect of the Rublevskaya water treatment station (RSV). RSV capacity is 1.35 million m3 / day. According to data from Mosvodokanal, a water supply reserve for new consumers is currently available. Sources of water supply of the territory in question are: highway d = 800 mm. along Berzarin Street, highway d = 600 mm. on the street People's Militia, highway d = 500-600 mm. along Marshal Zhukov Ave. [12].	The area is located within the area of affect of CHP-16 and CHP-25, which have a capacity reserve. The heating supply of the building is carried out along branches 2d = 200-500 mm from the heating main 2d = 700 mm of CHPP-16 along the Mnevniki street and from the heating main 2d = 1000 mm of CHP-25 along Marshal Tukhachevsky street. Consumers are connected to heat networks using heat points (CHP and ITP) [12].	The electrical power supply of the existing apartment block is carried out at a voltage of 10 kV from the substation PS: 110-10 kV «Hodynka» and CHP-16, which have a reserve power for technological connection [12].
5. Tsaritsyno District	The area is located within the area of affect of the Western Water Treatment Station (ZSV). According to the data of Mosvodokanal JSC, the ZSV capacity is 1.7 million m3 / day. There is a water supply reserve for new consumers. The water supply source of the area in question is the highway d = 900 mm at the intersection of Proletarsky Avenue and Kavkazsky Boulevard and the intra-block network d = 600 mm [13].	The area is located in the zone of the Lenin-Dachnoe RTS, which has a capacity reserve. The heating supply of the building is carried out by branches 2d = 400-500 mm from the heating main 2d = 800 mm. Consumers are connected to heat networks using heat points (CHP and ITP) [13].	The electrical power supply of the existing apartment block is carried out at a voltage of 10 kV from the power substations: 110/10 kV Belyaevo substation and 220/110/10 kV Substation Saburovo. Substation Belyaevo has a limited power reserve for technological connection [13].

3. Results and Discussion

The analysis we've performed makes it possible to describe the renovation sites engineering equipment supply as follows:

- renovation sites are located within zones of affect of Moscow water treatment plants with capacities that average 1.35-1.92 million m3 / day [9-13], which provides a water supply reserve to the new apartment blocks. Water supply sources are water lines and highways in the intra-quarter territory;
- renovation sites are located within zones of affect of Moscow CHP plant which are provided with a reserve capacity. The power sources are heating mains and TSTP / ITP;
- the renovation sites are located within zones of operation of electrical substations with a voltage of 6-10 kV [9-13], which mainly have a limited technological connection power reserve.

Summarizing the existing engineering and technical conditions of the renovation areas, we can conclude that the permanent (existing) engineering networks will not be able to

provide the necessary power reserve for the construction and installation works, namely the power supply network, therefore lining of temporary engineering networks and, as a consequence, the development of energy-saving measures at the construction site to preserve the fuel and energy balance of the renovation area are necessary[15-20]

Thus, the renovation areas in the city of Moscow, which are fuel and energy systems of the city, can be divided by water supply provision (WS), heat supply (HS) and electrical power supply (PS) (see table 3) into energy-poor (EP), energy-balanced (EB) and energy-redundant (ER), where RE is the power reserve index.

Table 3. Renovation areas typology on the basis of fuel and energy resources provision

S. No	Name	Characteristics		Symbol
1	Energy-poor (E_P)	Lack of FER reserves in:	water supply system (WS)	$\boldsymbol{E_P} = \begin{cases} \boldsymbol{f(WS, HS, PT, R_E)} \\ \boldsymbol{R_E} < 0 \end{cases}$
			heating supply system (HS)	
			electrical power supply system (PS)	
			a combination of two or more engineering equipment supply systems	
2	Energy-balance (E_B)	FER balance for all engineering equipment supply systems at a construction site		$\boldsymbol{E_B} = \begin{cases} \boldsymbol{f(WS, HS, PT, R_E)} \\ \boldsymbol{R_E} = \boldsymbol{R} \end{cases}$
3	Energy-redundant (E_R)	FER reserves (excess) availability in:	water supply system (WS)	$\boldsymbol{E_R} = \begin{cases} \boldsymbol{f(WS, HS, PT, R_E)} \\ \boldsymbol{R_E} > 0 \end{cases}$
			heating supply system (HS)	
			electrical power supply system (PS)	
			a combination of two or more engineering equipment supply systems	

4. Conclusions

The analysis of five renovation sites revealed a number of distinguishing features of engineering areas supply provision. For the most part Moscow renovation areas are divided into two forms: energy-deficient (EP), which lack reserve margins of fuel and power resources; energy-excessive (ER) which have an excess supply of fuel and power resources. Energy-balanced areas (EB) are considered to be of the highest possible level of renovation areas development. There renovation area fuel and energy balance is maintained at the stage of construction and installation works due to organizational and technological solutions aimed at energy preservation of energy resources within the construction site.

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