Experience in Innovative Technologies Application to Change Urban Space for Sustainable Territory Development

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Abstract. Linear objects can be a cause of environmental impact, and therefore, they require special protection for normal operation and accident prevention. For this purpose, special exclusion zones are established. Their size and operation mode depend on the type of a facility and a hazard class. The study object of the paper is a power cable located in the city of Tyumen, the Tyumen region. The article contains a detailed consideration of three challenges. The first one was to establish an exclusion zone for the facility mentioned above. The second one was registration of a land management file with the use of the GIS technologies. The third challenge was related to the cadastral registration of a land lot under the exclusion zone using the online portal “Rosreestr” (Federal Service for State Registration, Cadastre and Cartography).

1. Introduction
Linear objects are long objects whose length is many times greater than other dimensional characteristics. These objects include railways and roads, pipelines, power lines. Linear objects can be a source of environmental impact, and therefore they require special protection for normal operation and accident prevention. For this purpose, exclusion zones are established. Their size and operation mode depend on the type of an object and a danger class. Power lines are divided into two main types such as overhead power lines whose wires are suspended above the ground or above water, and underground (underwater) power lines whose cables are laid directly under the ground or in specially created tunnels. An overhead power line is one of the main links of modern power systems. The voltage in the line depends on its length and power transmitted over it. Overhead power lines transmit electric energy over considerable distances through wires attached to the supports by means of insulators. An underground power line consists of one or more cables, cable joins and terminal boxes, and fasteners. An underground power line containing oil (gas) filled cable is also equipped with a replenishing system and an alarm for oil (gas) pressure. Cables are laid under the ground, in trenches at depth with a range of 0.8-1 m in cable channels, blocks or tunnels. The most cost effective underground cable laying is composed of up to six cables in one trench with a distance between cables between 0.2-0.3 m. A laying is allowed to consists at least 20 cables in a tunnel. The capacity of underground cable lines is limited by laying conditions, and due to technical reasons the length of cable lines does not exceed 10-12 km. Consequently, underground power lines are local and less common. The first cable lines that appeared in Russia (in the late 17th of XIX century) were just underground (the radius of action was 1 km, the voltage was 2 kV). Electricity was mainly used to
illuminate private houses. Despite the fact that cable lines have been widely used for half a century, only now modern design and production technologies make them an effective alternative to overhead power lines.

2. Novelty
Changing the urban space of densely built-up areas involves searching for land to realize the effectiveness of energy policy and to plan their rational use. GIS and IT-technologies provide practically all services with information base at a qualitatively new level. And on this basis they provide the realization of technical, economic and a number of other tasks, including the formation of parcels. The purpose of the research is the process of forming a land parcel under exclusion zone and then, its cadastral registration using GIS and IT technologies.

3. Objects and Methods
The object of the study is a parcel for the safety zone of the cable power line in Tyumen, Tyumen region. Analytical and statistical methods, GIS technologies [1,2]. (MapInfo, Rosreestr portal) were used. Underground lines are used in the territory of cities and industrial enterprises. Due to densely built-up cities, overhead power lines are impossible. The main means of electrical energy supply are underground high-voltage cable lines (220 kV and above). They are the basic power lines in the modern city power system [3]. But they cost 2-3 times higher than overhead power lines. One of the drawbacks of overhead power lines is that they take up a lot of space. Legislatively, an overhead power line which is usually up to 25 m is banned in exclusion zones. Relaying power lines under the ground reduces the safety zone to 1m. The territories of many large cities have extended beyond "allowed to build." Therefore, the authorities and construction companies are looking for new land reserves for construction. And one of these reserves is a land parcel under overhead power lines. Every buried power line meter frees 25m² areas for construction.

Therefore, some companies have already started implementing this policy.

Power lines create around themselves an electromagnetic field that is harmful to human health. According to the information of the Center for Electromagnetic Safety, people living close to transformer substations and power lines may experience changes in nervous, cardiovascular, neurohormonal and endocrine systems, also disturbances in metabolic processes, immunity and reproductive functions. Considering the fact it is required to establish exclusion zones for such facilities.

The establishment of exclusion zones does not ban transactions with land parcels located in these zones. Restrictions are mandatory specified in the documents certifying the rights of owners or users of parcels (certificates, cadastral passports). Restrictions of rights concern the possibility (more precisely, impossibility) of conducting major construction works of objects with a long or permanent people stay (houses, cottages, production and non-process buildings and structures) under exclusion zones of overhead power lines. It is required to contact an electricity network organization for conducting a detailed analysis during the site construction under overhead power lines.

Exclusion zones are established along underground cable power lines. They represent a piece of surface land and a subsoil area beneath (corresponding to the depth of the cable power lines), bounded by parallel vertical planes spaced at a distance of 1 m on both sides of the power line from the outer power cables (lines voltage is up to 1kV in the cities under sidewalks at a distance of 0.6 m in the direction of buildings and 1 m in the direction of roadways) [4].

An exclusion zone is considered to be established from boundary registration date in the state registration system for estate. To create a power line exclusion zone a land parcel must be allocated with the appropriate purpose. The procedure for establishing object boundaries, a boundary description, and a cadastral registration is carried out in accordance with the land legislation of the Russian Federation for the time being.
4. Results

Tyumen is the administrative center of Tyumen region, one of the most developing cities in Russia, which is a significant social, economic, scientific, technical, and industrial potential. Its area is 698,48km² (General plan of Tyumen, 2017). The total area of residential buildings is 1,283,697 m² including 1,160,111 m² for high-rise blocks and 123,586 m² for private houses by the end of 2016. In comparison with the previous year, the area of residential houses has increased by 18.8%. The volume of private houses has increased by 1.8% (from 121.5 km² to 123.6 km²). Private housing occupies 9.6% of the total volume of housing (Complex development project, 2017). To provide houses with electricity in the urban district new power lines of various capacities are being built and old power lines are being restored.

Electricity in Tyumen is provided with a ring and radial network with 110 kV from three independent power sources: the turbogenerator unit - 1 (686 MW); the turbogenerator unit - 2 (755 MW); the electrical substation "Tyumen" (500 kV). The existing electricity distribution system does not cover the electric power shortage in Zatyumanka district and partly Zarechny district of the city. There are several local areas lacking electricity supply. The main measure to cover this lack is the construction of a gas turbine station in the western part of the city (Neftemash district), also supplying electricity for future areas of capital construction of Zarechnaya district of the city and the area of the Plekhanovo airfield (Scheme of territorial planning of Tyumen municipal formation, 2017).

Land management file on object boundary description (the exclusion zone of power lines) is formed through basic stages. Entering a land parcel in the cadastral register includes preparatory work, a boundary draft, an agreement on exclusion zone boundaries with the territorial body “Rostekhnadzor”, boundary location, the delivery of the land management plan to the state data base, information entry on exclusion zones boundaries of power lines in the state registration system.

During preparatory work, the source documents were carried out and it was established:

- a land parcel for establishing power lines is located in the cadastral area 72: 23: 0217004;
- a land category: human settlement land;
- permitted use for cable line establishment: a single-phase cable line (0.4kV), power distribution station 0.4 kV, transformer substation – 51, internal power distribution station 0.4kV, street Ordzhonikidze, Tyumen;
- a supervisory object name: a single-phase cable line (0.4kV), power distribution station (0.4 kV), transformer substation – 51, internal power distribution station (0.4kV), street Ordzhonikidze, Tyumen;
- a datasheet object name: a single-phase cable line (0.4kV), power distribution station (0.4 kV), transformer substation – 51, internal power distribution station (0.4kV), st. Ordzhonikidze, Tyumen;
- voltage type: 0.4 kV;
- length (km) (area): 2 x 0.105.

Field survey was carried out to clarify object location. Determining the coordinates of the characteristic points implemented in the local coordinates system №1 of Tyumen region adopted for registration of real estate cadastre in Tyumen region, using the analytical method, data from the Real Estate Cadastre of the fixed points (Resolution of the Tyumen region Government, 2017). The obtained error in determining the coordinates of characteristic points is within the limits of acceptable values according to Russian legislation. As a result of the calculations, the coordinates of 24 characteristic points of investigated object exclusion zone boundaries were obtained.

In recent years, due to the widespread introduction of electronic computers and design automation systems, analytical method has been increasingly used.

To create a plan, a geographic information system was used such as GIS MapInfo Professional v. 10.5. It is designed to collect, store, display, edit and analyze spatial data. This is the most common and easy-to-use desktop cartography system that allows to solve a wide range of tasks in various fields of activity. It helps to create and edit maps, analyze, store and process information related to
cartographic objects. From the point of view of the generally accepted GIS terminology, MapInfo is a spatial database management system (MapInfo Professional, 2014).

The plan of the land management object is made out on paper and in the form of an electronic document, certified by an electronic signature (Figure 1). Rotary (characteristic) points are created in a separate layer with the name "Rotary points". Exclusion zone boundary of the power line was designed in the "Border" layer using Polygon tool.

**Figure 1.** MapInfo Professional GIS Functional Window v. 10.5 with the land management plan.

The total area of the exclusion zone was 378 m², the length of a single-phase cable line (0,4 kV) is 197,53 m. To draw up a graphical map [9], topographic survey M1: 2000 (Tyumen city) was used. It was created in 2005. It was updated in 2009 (figure 2).

**Figure 2.** Exclusion zone boundary plan of the power line, str. Ordzhonikidze, Tyumen.
Exclusion zone boundaries of the investigated object were agreed with Russian technical supervision (Rostekhnadzor) on December 1, 2015.

Land survey work resulted in a land management file describing the land parcel boundaries (zone with special use conditions, an exclusion zone with a single-phase cable line (0,4kV), power distribution station (0,4 kV), transformer substation – 51, internal power distribution station (0,4kV), st. Ordzhonikidze, Tyumen).

To enter information on exclusion zone boundaries of electric power lines in the state registration system for estate the following activities were performed:

- appeal to the appropriate cadastral registration body for information entry on exclusion zones in the state registration system for estate; appeal for agreement on a land management plan created in the form of e–document using portal Rosreestr through an interagency electronic interaction system;
- information entry in the state registration system for estate;
- cadastral notification entry on exclusion zones of power supply network facilities in the state registration system for estate.

Information entry on exclusion zone boundaries of cable power line in the state registration system for estate was made within 30 days. The result of cadastral registration with assigned cadastral numbers is presented in the Public cadastre map portal of Rosreestr (Figure 3) (The Federal Service for State Registration, Cadastre and Cartography, 2017).

![Figure 3. A fragment of the public cadastre map of portal Rosreestr with the object under study.](image)

After information on exclusion area boundaries having been entered, The Federal Service for State Registration, Cadastre and Cartography in Tyumen region issued a certificate of the state registration of rights. The cadastral number: 72: 23: 0217004: 2338 was given to the object.
5. Conclusions
The study proved the advantages of underground power lines. Each buried meter of the power line free 25 m² of the site for building; the exclusion zone for the underground power lines in Ordzhonikidze Street in Tyumen was designed with the use of GIS technology for a short time. An exclusion zone was established with the area of 378 m² and its length of 197.53 m. Land management file was formed. Information about exclusion zone boundaries of the cable power line was included in the state registration system for estate using online portal “Rosreestr”: The Federal Service for State Registration, Cadastre and Cartography. The land parcel under exclusion zone was assigned 72: 23: 0217004: 2338 cadastral number. The Certificate of the State registration of rights was issued.

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