Method of an automated rapid assessment of the total required revenue in calculating the electric power distribution tariffs

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Abstract. The current electric power distribution tariff-setting processes are too complicated and subjective, and transaction costs in the power distribution industry make up to 50% of all the costs. The method of an automated rapid assessment of the Total Required Revenue of Distribution Network Operators suggested in the article is based on the identified dependencies between the Total Required Revenues of Distribution Network Operators, their cost items and operational indicators taking into account the possibilities of automated data collection from existing and sustainably operating state information systems. On the one hand, such an approach does not require additional expenses on creating and supporting new databases. On the other hand, it allows simplifying the information exchange between Distribution Network Operators and regulating organizations, to reduce the number of papers necessary for calculating electric power distribution tariffs, and to increase the rapidness of tariff-setting processes. As a result implementation of an automated rapid assessment of the Total Required Revenue in distribution tariff-setting processes allows reducing transaction costs and increasing the objectivity of calculations.

1. Introduction
Distribution networks are commonly maintained by Electricity Distribution Companies or Distribution Network Operators. Distribution charges cover all the expenses of Distribution Network Operators necessary for safe and reliable operating.

Today there are more than 1600 Distribution Network Operators in Russia. The electric power distribution industry is considered as a natural monopoly, so the functioning of Distribution Network Operators is regulated by regional executive authorities (Regulators) and the Federal Antimonopoly Service of the Russian Federation. The Federal Law "On Natural Monopolies" approved by the State Duma of the Russian Federation on August 17, 1995 sets out the main methods of state regulation of natural monopolies, one of which is tariff (price) setting. Regional energy commissions set distribution tariffs in Russia. They are assessed based on the total required revenue, the amount of consumed electric energy and connected load calculated for each of the Distribution Network Operators.

The main principle of tariff setting is recovering the capital and operational costs of the distribution network development and maintenance. On the one hand, the lack of financial resources prevents Distribution Network Operators from rapid and successful development. Very often, they have to borrow funds for investment or for covering current expenses so that they could provide a reliable
electricity supply. The necessity to repay loans with interest leads to an increasing rate of the required revenue and therefore, to the growth of distribution tariffs. Insufficient rate of wages provided from the distribution tariffs entails high staff turnover and impede innovative performance.

On the other hand, Distribution Network Operators are interested in the overstatement of their actual expenditures so that regulatory authorities approve a higher rate of the total required revenue. High rates of distribution tariffs cause downgrading of the economic situation in the country. That is why Regulators are interested in reducing the rate of tariffs.

To avoid unreasonable increase or reduction of tariffs Distribution Network Operators must prove their costs by presenting financial reporting, accounting data, tax returns, investment programs and other supporting documents to Regulators. The amount of paperwork needed to prove the validity of costs varies from several dozen to several thousand documents. It takes too much time to audit all the papers, to check the expenses and to calculate the tariffs. The reasonableness of Regulators` decisions depends on the qualification and number of experts. Sometimes Regulators make agreements with impartial expert organizations on examination of the Distribution Network Operators applications and papers for setting tariffs.

There are many surveys devoted to mechanisms of tariff regulation of natural monopolies [1-3] and schemes of price-setting for consumers [4-6]. However, very little research has been done on methods of getting information about the necessary costs for determining the adequate rate of the total required revenue.

This paper presents a method of an automated rapid assessment of the total required revenue based on the results of an investigation of the influence of different cost items of Distribution Network Operators on the total required revenues and the possibilities of automated data collection from existing and sustainably operating state information systems and other sources of information. Application of the suggested method can simplify tariff setting processes, reduce transaction costs, increase the speed and objectivity of calculations.

2. Materials and methods
Initially, the electric power industry in Russia was a state monopoly. Since the collapse of the Soviet Union, there was a single state-owned company RAO Unified Energy System that controlled most of the electric energy assets. In 2002, the Russian government began reforming the power sector, and by 2011 the electric power industry had been split up into generation, transmission, distribution and sales of electric power. Transmission and distribution sectors are qualified as natural monopolies.

The regulatory framework for these sectors in Russia consists of a significant number of legislative acts. The basic principles are set by Federal Law No. 35-FZ "On Electric Power", dated March 26, 2003 (Electric Power Law), and Federal Law No. 147-FZ "On Natural Monopolies", dated August 17, 1995. The rules of setting tariffs for transmission and distribution services are laid out in the Decree No. 1178 "On Price Setting in the Field of Regulated Prices (Tariffs) in the Electric Power Industry" approved by the Government of the Russian Federation, dated December 29, 2011.

According to this Decree Distribution Network Operators send applications to Regulators and attach to these applications, among other things, the following supporting documents:
1) actual power and electricity balance and information about the connected load of consumers;
2) financial and accounting reports;
3) forecast of the amount of consumed electric energy for the future period;
4) calculation of all the expenses and the total required revenue for electricity distribution activities;
5) documents that approve the reasonability of all the expenses of the Distribution Network Operators;
6) investment programs;
7) documents that approve lawful possession of distribution network assets;
8) information about the contacts and website of the Distribution Network Operators;
9) electricity supply schemes with marked overhead lines, substations, cables and supply points.
The applications are to be sent by May 1 of the year previous to the regulatory period. Then Regulators request additional documents, and they usually set tariffs by the end of December. It means that examining papers and the decision-making process lasts for more than half a year.

The architecture of information flows in the contemporary tariff-setting process has been examined, and it is shown in Figure 1. Both the scheme of information flows and the number of judicial decisions on the repeal of tariff settlements prove that the process of setting tariffs for Distribution Network Operators is too subjective and complicated. As a result, half of the distribution costs are transactional ones.

![Figure 1. Architecture description of information flows in the actual tariff-setting process: DNO – Distribution Network Operator; 1...n – the sequence number of a Distribution Network Operators; Balances – actual and planned for the future period balances of electric energy and power; Expenses – calculations of all actual and planned expenses and the supporting papers; Inv.Pr. – investment programs; R&Q – reliability and quality indicators of electricity supply; Composite Balance – the composite balance of electric energy and power of all the Distribution Network Operators in the region; TRR – total required revenue; Lim TRR – the maximum rate of the total required revenue; ∑TRR – the sum of total required revenues of all the Distribution Network Operators in the region; ∑Lim TRR – the sum of the maximum total required revenues of all the Distribution Network Operators in the region.]

The information about cost items of 28 Distribution Network Operators in the Tula Region of Russia has been analyzed on the basis of calculating pair correlation coefficients and determining the qualitative dependencies between the total required revenues of the Distribution Network Operators set for the year 2018, cost items of the Distribution Network Operators (i.e. labour costs, materials, repair costs, taxes) and operational indicators (i.e., connected load, amount of distributed electric energy, number of connection points, amount of assets). The investigation has been held with the use of IBM SPSS Statistics (Statistical Package for the Social Sciences). It has been established that the strongest dependencies are between the total required revenue and two variables: payments to the state insurance funds (the correlation coefficient is 0.96) and the amount of distributed electric energy (the correlation coefficient is 0.93). The linear regression model of the approximate total required revenue is the following:
TRR = 525.319 + 8.924 I + 0.302 E,  

(1)

where TRR is the total required revenue in thousand of rubles, I is the sum of payments to the state insurance funds in thousand of rubles, E is the amount of distributed electric energy in millions of kilowatt-hours. The model has been validated by calculating the approximate TRRs for Distribution Network Operators of the Tula Region of Russia for the years 2019 and 2020 and comparing the results with the set sums of the total required revenues. Thus it can be used for a rapid assessment of the TRRs of Distribution Network Operators.

For increase the speed and objectivity of calculations, it is necessary to automate the data collection processes. The sums of payments to the state insurance funds can be received from the information system "Tax-3." It is the Automated Information, and analytical system of the Federal Tax Service of Russia (https://www.nalog.ru/rn77/about_fts/gos_inf/4045827/) and its database contains information about all the taxes and charges levied by the government from all the organizations in Russia. The information about the amount of distributed electric energy can be received from smart meters, which are to be set all over Russia by the 1st of January, 2023, under the Federal Law No. 522-FZ, dated December 27, 2018. The architecture of information flows for an automated rapid assessment of the total required revenue in calculating the electric power distribution tariffs is presented in Figure 2.

Figure 2. The architecture of information flows for an automated rapid assessment of the TRR (total required revenue) in calculating the electric power distribution tariffs.

For prevent Distribution Network Operators from inflating their total required revenues by an overstatement of payments to the state insurance funds, it is necessary to implement a spot check of the actual costs of Distribution Network Operators on the basis of data received from independent sources, such as smart meters and state information systems.

3. Results and Discussions
The equation (1) for the approximate total required revenue may be used for a rapid assessment of the total required revenues of Distribution Network Operators in the Tula Region of Russia. It has also proved to be true for sample Distribution Network Operators of some other regions. Nevertheless the usage of this equation for a rapid assessment of the total required revenues of Distribution Network Operators in other regions of Russia needs some further investigation.

The spot check of the actual costs of Distribution Network Operators can be implemented on basis of the data received from the following state information systems: Unified information system in the field of procurements (http://zakupki.gov.ru/epz/main/public/home.html), Automated Information and analytical system of the Federal Tax Service of Russia “Tax-3” (https://www.nalog.ru/rn77/about_fts/gos_inf/4045827/) and the database of Federal Service of State registration, inventory and cartography (https://rosreestr.ru/site/). The databases of these systems contain information about all the estate objects, most of the procurements and all the taxes. The allocation of average shares of expenditures of Distribution Network Operators according to the sources of information about them is shown in Figure 3. Thus, about 88% of all the actual costs of Distribution Network Operators can be checked just through the data exchange between state information systems without collecting numerous papers by regional executive authorities.
Besides, it is necessary to control the reliability and quality indicators of electricity supply. These indicators can be automatically calculated according to the methodical instructions adopted by the Order No. 1256 of the Ministry of Energy of the Russian Federation, dated November 29, 2016. The data for calculations can be received from smart meters. The architecture of information flows for an automated process of a spot check is presented in Figure 4. All the information should be aggregated and processed in specialized data centres. As a result, the information exchange and all the calculations connected with setting distribution tariffs should be automated.

4. Conclusion

The approach to design information exchange in power distribution tariff-setting process in terms of digital economy investigated in the article allows simplifying the tariff-setting process, increase the accuracy of calculations, reduce the time required for taking power distribution tariff decisions and as a result to reduce transaction costs in the power distribution industry. Moreover, it is based on the use of existing and sustainably operating state information systems, so it does not require additional expenses on creating and supporting the new ones.

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