

“Smart energy” as a factor of sustainable ecological-and-economic development of the region

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Abstract — This work addresses issues of development of the world’s most rapidly growing smart cities-smart energy market segment in Russia. The analysis of the current situation allows us to conclude that, despite a certain technological lagging of energy in Russia, the transition to the “smart energy” system is possible, providing the solution of such problems as the development of a strategy at the federal and regional levels, the development of standards aimed at environmental improvement and energy efficiency and conservation. It seems that one of the factors conducive to the development of smart energy in Russia is the modernization of the system of environmental charges that began in 2016. It is stated that to develop the standards, it is necessary to investigate the relationship between the quality of life indicators and the "smart energy" development indicators.

Keywords — *smart energy, region, ecology, quality-of-life indicators, economic loss*

I. INTRODUCTION

Скачайте файл с шаблоном статьи. Сохраните ваш The reorientation in the strategy for the development of cities, regions, republics by type of "smart city" is aimed at a radical realignment of the goals, objectives, standards, the quality-of-life indicators, focused on sustainability and reduction of the resources consumed costs.

The key to successful implementation of the "smart city" concept is active participation of residents in the lives of their settlements, cities, towns and other territories and managing these territories with the use of intellectual and information systems based on ICT [1]. The International Telecommunication Union (ITU) highlights eight key areas of the infrastructure improvement that are necessary for regional development by the "smart city" type. These are: energy, buildings, transport, water, waste, protection against physical violence and safety, health, education [2, 3].

According to the consulting firm Frost & Sullivan, that deals with market research and analysis, smart energy is the fastest-growing segment of the smart cities market. The

segment will be stimulated by the mass integration of smart grids and smart energy solutions. In 2014, Frost & Sullivan predicted that smart energy will constitute 24 percent of the total smart cities world market by 2025. Meanwhile, the average annual growth rate in the period from 2012 to 2025 will constitute 28.7 percent [4].

Over the past decades, the specialists of different countries have become more interested in analyzing the connection between the quality-of-life indicators and the indicators of the "smart energy" development. A lot of well-known foreign scientists devoted their works to the development of methodological approaches based on the provisions of ISO 37120, in order to assess, to which extent the urban development is consistent with the objective of sustainable development. The surveys of these researches can be found in the works of scientists R. Girardi, A. A. Temporelli, L. Anthopoulos [5, 6].

Intellectualization of energy systems is already currently incorporated into the sectoral strategic documents in Russia. Not so long ago, in 2017, the Outlook for the scientific and technological development of the fuel and energy sector of Russia until 2035 was approved [3], and a project of the Energy Strategy of Russia until 2035 was developed [7].

In the context of implementation of the "smart city" concept, reducing the negative impact on the environment becomes a very important objective, inextricably linked to smart energy. According to the economic activity in the regions of Russia, the analysis of air pollutant emissions shows that in a number of regions, the production and distribution of electricity, water and gas rank first in the contribution to emissions [8]. In this regard, the study of the prospects for smart energy as a factor of sustainable ecological-and-economic development of the region is very relevant.

The purpose of the study is to assess the effectiveness of the stimulating approaches to the development of "smart energy" by the example of the Stavropol Territory. The

estimates obtained will make it possible to work out the strategy, motivating enterprises to develop innovative technologies and to implement "smart energy".

The main objectives of the research are:

1. To define priorities in the development of "smart energy".
2. To provide the rationale for the need to assess the relationship between energy efficiency and conservation indicators and the quality-of-life indicators.
3. To affirm the need to refine the standardized set of indicators, since it is insufficient to assess the development of all areas of "smart energy".
4. To identify the aspects of state regulation that could encourage the enterprises to actively participate in the development of "smart energy."

The key objective is to create conditions for the development of all areas of "smart energy", which ensures the increase of the quality of life indicators in the region and income growth as a result of its own increased competition. The critical role here is attributed to partnerships with the state administration bodies, power industry enterprises and population.

II. MATERIALS AND METHODS (MODEL)

Regardless of whether there will be a quantitative increase or decrease in the consumption of such energy resources as heat, gas, electricity, depending on the population growth in the region and, perhaps, the increasing range of energy services provided to it (for example, electric cars), the direction of the development is clearly indicated, namely the reduction of harmful effects on the environment and the increase of all technological processes efficiency.

This is particularly evident in the methodology of international organizations working out standards in the areas of "smart city" development, including "smart energy". Each of the presented indicators assesses the possibility of reducing the energy resources cost and increasing the economic effect, reveals the connection between energy conservation and energy efficiency in manufacturing and in the social life of society. It makes it possible to compare the level of energy conservation and energy efficiency at the existing level of the technological stage and the predicted one.

In May 2014 the International Organization for Standardization or ISO issued the standard ISO 37120: 2014 on indicators for the "smart city". In ISO 37120: 2014, indicators such as economics, education, energy, the environment and others are defined [9].

Using the example of urban settlements, these indicators allow to assess the level of "smart energy" or "smart economy" at a certain point in time and to determine the opportunities for accelerating the positive growth of these indicators, taking into account attraction of investment and the time period.

The International Telecommunication Union (ITU) and the UNECE have joined their forces to build smart cities and developed their indicators differentiating them, such as the environment which includes energy, air quality, noise, water supply and others [10]. The developed classifications confirm the interconnection between the quality of life indicators and the state of the environment, energy and economy. Moreover, priorities, related to improving the ecology and habitat quality, are identified.

The methodology developed by the famous scientist, the quality management expert U. Deming, who claimed that only the target management of the organization as a system makes it possible to optimize it, can serve as a role model for us. At the same time, all the interconnections between the components of the system are also optimized, which is what happens when development of the directions of the "smart city" takes place. In addition to optimization, a synergistic effect can be observed.

In Russia, the indicators of urban services and quality-of-life indicators are developed in accordance with GOST (the State Standard) R ISO 37120-2015. This family of standards is being worked out to provide an integrated and holistic approach to sustainable development and viability. The proposed standardized set of indicators defines a unified approach to determining what is required to be measured and how to carry out these measurements.

The so-called quality of urban services indicators and the quality of life indicators can be currently used to monitor and assess the quality increase in terms of effectiveness and efficiency of all processes related to the environment, both of the city and any other territory. It is obvious that sustainable development is possible through equal development and investment in all areas of the "smart city" type.

In the State Standard, the indicators are grouped by sections. Taking into account the differences in the resourcing and the capacity of urban settlements and other territories, all indicators are divided into "key" indicators (they are binding on everyone who adopted this standard) and "auxiliary" indicators (which "interpret" the content of each key indicator and are provided to assist those who apply this standard) (Table 1).

With the worldwide implementation of the "smart energy" methodology, the Russian energy sector is just approaching a new stage that is in general changing the life cycle of the energy sector. The global objective is now to achieve a harmonious interaction between energy and the environment, aimed at improving the quality of life and the economy as a whole. It should be noted that over the past years, programs, concepts, strategies for the future development of "smart energy" were being developed.

TABLE 1. THE URBAN SERVICES QUALITY INDICATORS AND QUALITY OF LIFE INDICATORS

Sections (urban life aspect)	Key indicator	Auxiliary indicator
Economy (section 5)	Unemployment rate in the city Estimated value of commercial and industrial real estate as a percentage of the total estimated value of the total property Proportion of urban population living below the poverty line	Proportion of population having a permanent job Unemployment rate among young people Number of business entities per 100,000 inhabitants Number of patents per 100,000 inhabitants
Power industry (section 7)	Total household energy consumption per capita (kWh / year) Proportion of urban population having an authorized connection to the electricity grid Annual energy consumption by the public buildings (kW / ml) The share of total amount of electric power from renewable sources in total energy consumption in the city	Total energy consumption per capita (kWh / year) Average number of power outages per consumer per year Average duration of power outages
Environment (section 8)	Concentration of finely dispersed suspended particles (PM2.5) Concentration of suspended particles (PM10) Greenhouse gases emissions in tons per capita	Concentration (nitrogen dioxide) Concentration (sulfur dioxide) Concentration (ozone) Noise pollution The relative quantity change

Let us consider the key provisions of the "Energy Strategy of Russia for the period until 2030". Here, the development and practical implementation of a new generation of smart grids is considered to be the top priority area of scientific and technical progress in the country's energy sector. The introduction of these grids into already existing energy systems should be performed with high indicators of the integration, which should ensure the creation of systemic and clearly distributed grids in the Unified Energy System of our country.

The development of an energy strategy at country level formed the basis for the development of regional strategies. Thus, a strategy for the development of the fuel and energy complex of the Stavropol Territory for the period until 2020 [11] has been developed. One of the priorities of the regional energy sector development includes the development and use of renewable energy sources, as the most environmentally friendly and sustainable areas.

There is therefore an approach to a wider range of different areas of the energy sector development, which is underpinned

by natural and climatic characteristics of the territory. The strategy of the territory also includes the concept of economic energy security, options for a modernization strategy, including indicators for pollutant emissions reduction, energy-saving programs and innovative technologies.

It should be noted that, despite being monopolists in this sphere, the energy organizations of the Stavropol Territory will not be interested in the development of "smart energy" without being stimulated by state bodies. Moreover, the existing penalty system for the negative impact on the environment is rather formal, since it does not significantly affect the income of the organization, managers and employees.

Public authorities should develop rules, restrictions and a number of incentives to be used in regional programs to improve the environment and energy conservation.

Let us consider activity of the power company of Lermontov of Stavropol Territory as an example of implementation of methodology, stimulating energy efficiency and environmental safety. The main activity of the branch of CJSC "SEC" (Southern Energy Company) is the generation and sale of electricity and heat energy for the consumers. The enterprises of various forms of ownership and the population of the city of Lermontov are defined to be the consumers.

Among the immediate objectives of the branch of CJSC "SEC" are the installation of additional power capacities, and accessing the wholesale power market.

Let us compare two options, according to which the negative impact on the environment was assessed separately for each pollutant. The first option formally included measures and penalties for energy companies for damaging the environment, namely, the deduction was made within the limits of the calculated payment for the negative impact on the environment separately for each pollutant. The documented costs incurred in the reporting period to finance the activities under article 17, paragraph 4, of Federal Law No. 7-FZ of 10.01.2002 "On Environmental Protection" and included in the environmental protection action plan or in a program aimed at eco-efficiency, are attributed to the cost for the measures' implementation aimed at reducing the EIA.

The second version of the law is oriented at the implementation of "smart energy", since it includes the mechanisms that encourage the reduction of air pollutant emissions, although it obliges the enterprises to apply it only commencing on January 1, 2020.

The most important point is increasing the penalties. This approach contributes to the improvement of the region's ecology, but the methodology itself needs further development in order to use new directions of the energy development.

If we compare the two versions, we will see that the current approach did not stimulate enterprises to develop the "smart energy". As an example, let us consider the calculations for the ratio of payments and damage for the energy organizations of Lermontov for the second option.

III. RESULTS AND DISCUSSION

Let us take the calculation of the amount of damage and payment for the negative impact from the specific substances emissions into the atmosphere by the branch of the CJSC "Southern Energy Company" in Lermontov (the full range of substances includes 26 elements) for estimation [12]. With the use of the "Temporary Methods of Determining Prevented Environmental Damage" (1999) [13], we calculate in 1999 prices, and the use of deflators indexes allows us to see the result in 2015 prices provided in Table I. For the Stavropol Territory, where the city of Lermontov is located, the coefficient of the sum of the economic specific damage estimation from air pollutant emissions is 68.7 rubles / cond. t. (in 1999 prices).

Let us use the same pollutants to calculate the payments for the negative impact that was subject to payment for the emissions limited by the established norms (see Table I). The Government Decision No. 632 of 28 August 1992 valid in 2015 "On approval of the Procedure for determining payment and its limits for environmental pollution, waste disposal, and other environmental impact" [13], was used in the calculations. A coefficient allowing for inflation in 2015 was used in the calculations.

TABLE II. THE ECONOMIC LOSS CALCULATION PARAMETERS, 2015

Substance	Released into the atmosphere, tons	Coefficients of relative economic hazard of air pollutant	Estimated damage, rubles
Nitrogen (II) oxide (Nitrogen oxide)	14.2954374	33.5	389030.72
Sulfur dioxide (anhydrite sulfurous)	0.1606771	20	2610.51
Benzo(a)pyrene (3,4-Benzpyrene)	0.0000702	12500	712.83
Sulfuric acid per molecule (H2SO4)	0.004482	20	274.16
Iron (II, III) oxides (Iron oxide)	0.0987735	33.5	2687.99
Carbon black (soot)	0.0067553	33.5	183.84
Total			395500.05

The total calculated damage assessment values (see Table I) and payments for the negative impact (see Table II) differ 128.8 times for 6 types of pollutants emissions. You can find a comparison of payments for air pollution and the related economic damage for a full range of pollutants in 2015 prices in Figure 1 (1 \$ = 57 rub.).

TABLE III. THE ENVIRONMENTAL PAYMENTS CALCULATION PARAMETERS, 2015

Substance	Released into the atmosphere, tons	Payment norms per 1 ton of pollutants emission, rubles	Payment for the negative impact, rubles.
Nitrogen (II) oxide (Nitrogen oxide)	14.2954374	35	2353.60
Sulfur dioxide (anhydrite sulfurous)	0.1606771	21	12.83
Benzo(a)pyrene (3,4-Benzpyrene)	0.0000702	2049801	676.89
Sulfuric acid per molecule (H2SO4)	0.004482	21	0.44
Iron (II, III) oxides (Iron oxide)	0.0987735	52	24.16
Carbon black (soot)	0.0067553	80	2.05
Total			3069.97

The calculations made by the authors highlight, that the principle of the environmental policy: "polluter pays," has not been fully implemented for a long time and is not being implemented so far. According to the actual ratio of environmental payments and economic damage, it is obvious that it is possible to encourage the enterprises to actively participate in the development of smart energy, only by means of reforming the payment calculating approaches, increasing them, while deducting for the costs of smart technologies introduction.

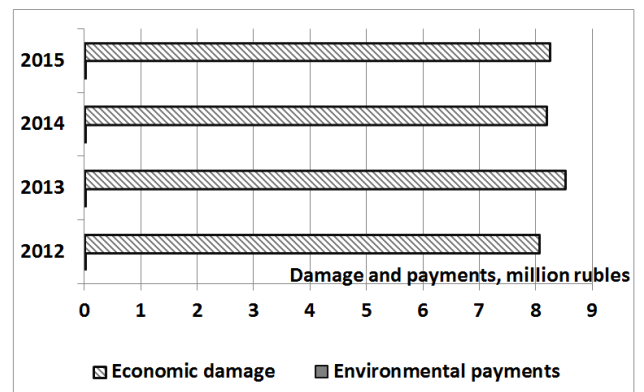


Fig. 1. Comparison of the sizes of the economic damage and payments for environmental atmospheric emissions for the energy facilities in Lermontov

IV. CONCLUSION

From the standpoint of the national economy and the regional development, the combination and interconnection of economic and social factors becomes the top priority. High technological level of energy, especially in cities, improvement of environmental indicators, involving the population in the expanding sources matters in the field of energy act as conditions for creating an environment, where the smart energy strategy could be implemented in Russian cities.

The further research suggests:

1. Developing the expert "smart energy" model, that would make it possible to work out and classify the statistics on the residents' needs of the region according to the quality of life standards.

2. Administering a survey to collect information in social media in order to set priorities in the needs of different regional communities.

3. Monitoring the distribution of the investments, taking into account the assessments in the development of the "smart energy" field.

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