Asian Social Science; Vol. 11, No. 11; 2015
ISSN 1911-2017 E-ISSN 1911-2025
Published by Canadian Center of Science and Education

The Development of Housing-and-Communal Services Power Supply System in Samara Region

Ajupov A. A.[1], Kurilova A. A.[2] & Sherstobitova A. A.[2]

[1] Kazan Federal University, Institute of Management, Economics and Finance, Kazan, Russia

[2] Togliatti State University, Togliatti, Russia

Correspondence: Kurilova A. A., Togliatti State University, Togliatti, 445667, Russia. Tel: 79-17-122-3879. E-mail: aakurilova@yandex.ru

Received: March 10, 2015 Accepted: March 31, 2015 Online Published: April 30, 2015

doi:10.5539/ass.v11n11p176 URL: http://dx.doi.org/10.5539/ass.v11n11p176

Abstract

In the article the authors consider the problems of the development of housing-and-communal services power supply system in Samara region. The methods of evaluating the housing-system activity and the model for the managing development are suggested for solving problems in this sector of economy.

Keywords: development of social and economic systems, balancing system, electricity prices, procurement costs, reserve requirements, supply-demand balances, cost of energy transferred from the supplier to consumer

1. Introduction

The transformations in the economy of our country including housing-and-communal services (HCS) led to the situation that nowadays heat and electric energy supplying practice of HCS is based on the both unprofitable and expensive technologies. This can be explained by power shortage in Russian power economic environment equipment became obsolete; there is the discrepancy between economic-organizing mechanism of energy-supply system and modern qualifying standards to HCS from consumers. Besides, there is a problem expressing itself in the lack of metrics, characterizing the development of a brunch and allowing estimating the efficiency of HCS objects energy supply system. The lack of estimation procedure doesn't let us form a pattern for energy-supply system development and reduce the costs on HCS qualitative functioning in general and flatten out the rates.

The condition analysis of existing HCS system in Samara region showed a lot of problems affecting the development and efficiency of HCS energy-supply system. The main problems of communal services subsystem in Samara region are denominated by the shortage of investments in development and updating of the objects producing and distributing energy; by low efficiency of the fuel and energy resources used by HCS enterprises; by the absence of the mechanisms optimizing the fuel consumption and energy-saving technologies used on the territory of Samara region.

The economic characteristic and analyses of condition of existing energy complex in region in the sphere of energy supply for population and energy consumption by industrial and social sectors presents the following: The energy supply power shortage from centralized sources; The big volume of the losses in the electric and heat networks because of the technical condition and imperfection of electric and heat energy accounting system, also because of a long distance between the energy sources and the energy consumers etc.

2. Theory

The history of formation and development of consumers power supply system in country started by implementation of State plan of Russian electrification which was developed by professor Krzhizhanovsky in 20ties of 20th century. The main idea of that plan was the placing of energy and power objects according to the available industry on the certain territory. It was done without consideration of needs of housing and communal services.

The author of the article has done both the historic and theoretical analysis of this economic branch and considered six stages of it development. The first stages (since 20ties for 90th years of the twentieth century) are characterized by positive dynamics of development of system. Last stages (since 90ties of the twentieth century) are noted by negative tendencies of decrease in input of new capacities and works on modernization in system.

The modern organizational-economic mechanism of system of power supply of housing and communal services does not correspond to requirements and is not aimed to the development.

Theoretical aspects of the analysis of laws of development of social and economic systems have been put during an epoch of classical political economy. Economists of this period have paid for the first time attention to a source of efficiency of functioning of economy, having made object of the analysis manufacture sphere as a source of its riches. They have put methodological base of research of social and economic processes.

Being based on postulates of classics of political economy, K. Marx has added and has created the complete doctrine from the methodological point of view about developments and evolution of social and economic systems. In the course of research of an economic reality K. Marx leant directly against Gegel's dialectic postulates owing to what its works represent not only the theoretical base of the analysis of the social and economic phenomena, but also the complete world outlook concept.

Essentially other methodological approach was suggested by representatives of a traditional branch of the economic analysis: neoclassics and institutionalists. Sources of research of processes of social and economic dynamics had an individual – *the person economic* (homo economicus), and the model of a rational choice becomes the basic model of the analysis. Accordingly, the greatest interest represents the analysis of behavior of the individual in social and economic system.

One more mark in development of methodological base of the analysis of social and economic systems are N.D. Kondratyev's works. The base of its research is the assumption of recurrence of development of world economic system. The first mentions of presence of long waves of an economic conjuncture have appeared in the 20th century beginning in works of the Dutch economists, but recognized leadership in working out of a problematic of the big cycles belongs to N. D. Kondratyev. Kondratyev has established presence of the big waves of an economic conjuncture of the capitalist countries an empirical way, having analyzed dynamics of change of various macroeconomic indicators in such countries as England, France, Germany, the USA from the 18th century end on the 20th century beginning.

At the present stage the economic science closely co-operates with natural sciences owing to what there is a creation of the interbranch concept of the analysis of difficult dynamic systems which the social and economic system concerns also. About it tell last empirical researches in this area owing to what a number of scientists proves necessity of introduction of postulates of the theory of chaos and the synergetic which is for today a key to understanding of those tendencies which take place in development of world social and economic system.

So, according to the Russian and foreign researchers, development is a uniform complete process which can be considered only in relation to system as this process grows out of co-operative action of elements of system. If we wish to investigate development of a separate element should present this element in the form of system, having spent its splitting into elements and having allocated an environment. As a measure of organization of system the entropy understood in a broad sense can serve. The system condition is defined by distribution of its elements possessing the given sign, a measure of their orderliness. Entropy of system can be defined for various levels of aggregation of its elements.

3. Results

Having analyzed the theory and definition of the subject in economic literature, the authors suggested to use the following definition for the *development of power supply system in housing and communal services*.

Development of power supply system in housing and communal services is a purposeful change of system, its qualitative condition by ranging of a choice and perfection of parameters, properties and mechanisms of the internal environment of system taking into consideration revolting influence of factors of an environment. The primary and starting moment of development of system is its purpose. The development has a constant character, realizing the mission of system of power supply of housing and communal services which is the economic and qualitative satisfaction of requirements for thermal and electric energy. The diagnostics of development of system of power supply of housing and communal services is a system of research receptions united by uniform logic and a technique. Its task is the definition of the real level of development reached by system of power supply during the given certain moment of development. Now we make a model of optimal energy supply for consumers using the method of dynamic programming (DP method). We use this method on the last stage, when the optimal states of each energy supply system components will be found. At first we should name the main stages of the DP method economics model making.

1) Dividing the problem into stages. Each stage should be not very small and not very big. On the Figure 1 we can see all the stages of energy moving from a supplier to a consumer. On the 1st stage the fuel supply is made.

On the 2nd stage every energetic object produces energy. On the 3rd stage the energy distribution to consumers according to energy distribution terms begins.

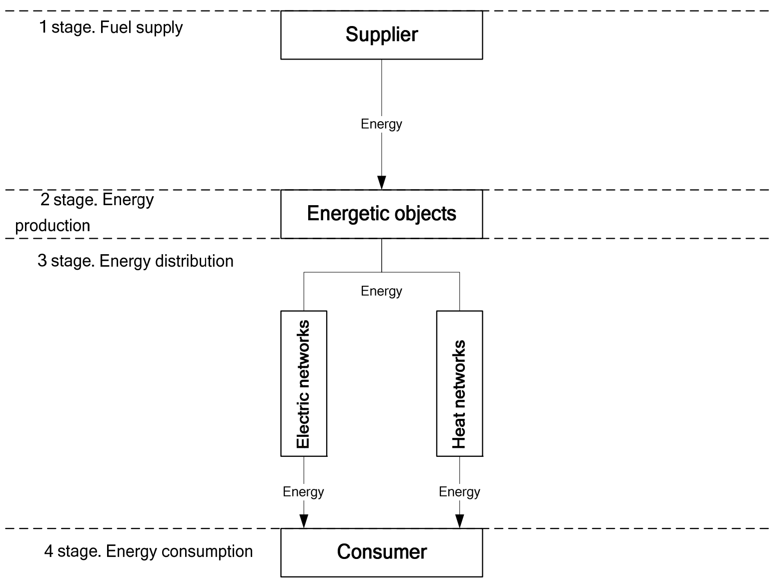

Figure 1. Stages of energy moving

2) The choosing of variables, characterizing the state of model-based process before every stage, and the revelation of the restrictions. In our case this restriction will be the reliability of energy supply.

3) The detection of management stages X_i ,*i=l…m* and of the restrictions, i.e. the range of acceptable managements X.

According to the 1st stage, before the solving problem using DP method, we should distribute the amount of the produced energy to the consumers according to their demands. We can do this using the solution of co-called transportation problem. And then we should set the following restrictions:

Fuel consumption $\longrightarrow$ min

Energy losses by production $\longrightarrow$ min

Energy losses by distribution $\longrightarrow$ min

The number of consumers $\longrightarrow$ max

The number of power plants $\longrightarrow$ min

The problem efficiency index will be designated as W, and the efficiency indexes for every stage - φ_i ,*i= 1…4.*

If W possesses the property of additivity, then we can write down

$$W=\Sigma\varphi_I , \quad (1)$$

where

φ_1 – the efficiency of fuel supply stage;

φ_2 – the efficiency of energy production stage;

φ_3 - the efficiency of energy distribution stage;

φ_4 - the efficiency of energy consumption stage;

Variable X_i , on which the efficiency on a stage i , depends and therefore the whole efficiency is called stage management, *i=l…m*.

The process management in general (X) is called sequence of stages management (commands vector) $X=(x_1, x_2, \ldots x_i, \ldots x_m)$.

In our example the most important stage is the stage 3 (the stage of energy distribution), so we should consider it in details.

We are to use two-step mechanism for the optimization of this stage, solving the transportation problem, first and then optimize using the DP method.

The following factors are necessary to perform these problems:

We - the capacity of energy produced by the equipment;

Wcs - the capacity of energy consumed by population;

R- the total distance between the generating equipment and consumers energy. Meanwhile

$$R = \sum_{i=1}^{n} \sum_{j=1}^{m} r_{i,j} , \quad (2)$$

Where

r_{ij} – the particular distance between the generating equipment and energy consumer; $i=1 \dots n;$

n- the number of generating equipment;

m – the number of energy consumers.

Meanwhile

$$Wcs\,(R) \rightarrow We, \quad (3)$$

We will take into consideration the cost of transferred energy from *i*-consumer to *j*- supplier $C_{ij}$and will find the loss (expenses), taking into consideration the request in the energy need of a particular consumer W_c,with a formula

$$P=C_{ij}*W_c*R_{ij}, \quad (4)$$

Where

$C_{ij}$is the cost of transferred energy of $W_c$content on the distance from source *i*to the consumer j (R_{ij}).

Then we need to examine the functional for optimizing objective effectiveness function (the efficiency of the region electricity supply system functioning tends to max). The additivity is one of the reasons of DP (dynamic programming) application. The energy-supply system is complicated one. We need to solve it optimizing every step. We determine the efficiency of every step – one of the constituent according to functional

$$F=f\,(W, R, P) \quad (5)$$

Thus, the application of optimal control theory can be scientific base of the consumers' optimal energy-supply mechanism. The optimization mechanism is the combination of the economic-mathematical modeling in the form of transport problem and dynamic programming, which allow determining the optimal composition of the functions' totality, describing the area consumers' energy-supply.

The number of mini-heat station is determined by the demanded energy $We \cong Wcs$, where Wcs depends on *R* and Wcs depends on

$$R= \sum_{i=1}^{n} ri \quad (6)$$

Then

$$Wcs\,(R) \rightarrow We \quad (7)$$

We choose the Samara region to calculate the model confirmations:

We need to know:

m – the number of boiler houses

n – the number of consumption objects

The distance from *i*-supplier to *j*-consumer

The loss (p) for 1km,

The cost of energy transferred from the supplier to consumer.

4. Conclusions

We will perform calculations according to data of Pokhvistnevo town in Samara region.Today there are six boiler houses in Pokhvistnevo. They have a summary heating efficiency of 52 Gcal/h on an average.We suggest the using of two mini- heat stations with a summary efficiency of 62 Gcal/h. It is proved by solving the transport problem.

Thus, we introduce the strategy of the development evaluation of the HCS energy-supply system presented on the figure 2. The given strategy is a procedure, which includes a set of rules, algorithm according to which we can estimate the development of the HCS energy-supply system. The suggesting strategy consists of four interconnected stages. On the first stage the condition of HCS in terms of indicators correspondence to the environment is estimated. As a rule the controlled indicators are compared in dynamics and the problems of the existing branch condition are revealed. On the second stage the possible courses of system development through the improvement of some factors are analyzed. On the third stage the correlation of factors and their final influence on the whole test subject is disclosed on the base of these and other factors. On the fourth stage directly the development of energy-supply of HCS system is designed. We should describe every stage more detailed.

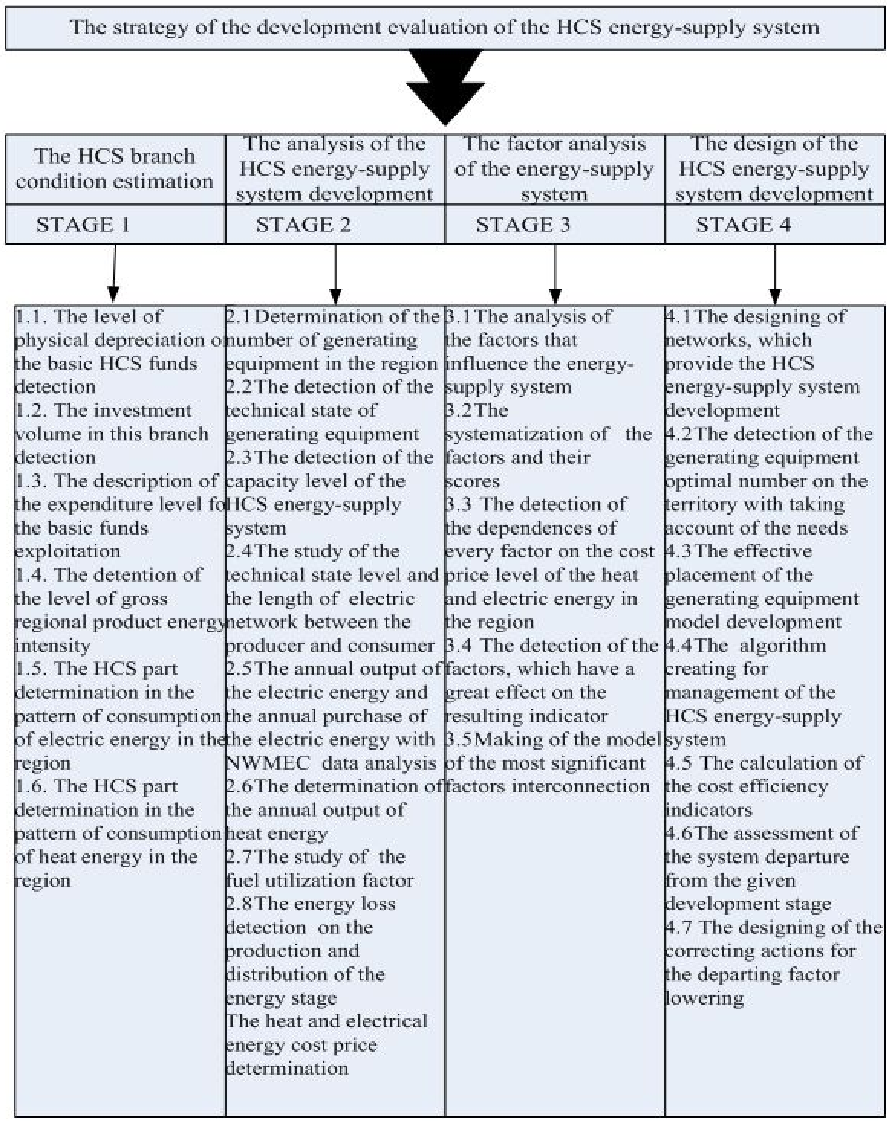

Figure 2. The strategy of the development evaluation of the HCS energy-supply system

On the first stage it is necessary to estimate the branch condition on the particular territory. And the basic indicators, describing the level of HCS condition should be revealed. We defined the following indicators: level of physical depreciation of the basic HCS funds, the investment volume in this branch, the expenditure level for the basic funds exploitation, the level of gross regional product energy intensity, the HCS part in the pattern of consumption of heat and electric energy.

The next stage is connected with the analysis of the HCS energy-supply system development. On this stage there are the following important indicators: as the number of generating equipment in the region, its technical condition level, the capacity level of the HCS energy-supply system, the technical state level and the length of electric nets between the producer and consumer.

On the third stage factor analysis of the energy-supply system is carried out with a purpose of the basic factors detection, which finally influences the heat and electrical energy cost price. It is necessary to define the following: to analyze the factors, which influence the development of the energy-supply system; to systematize the factors and their scores; to detect the influence of every factor on the cost price level of the heat and electric energy in the region; to detect the factors, which have a great effect on the resulting indicator; to make the models of the interconnection of the most significant factors.

On the last stage the HCS energy-supply system development is designed. The fourth stage is based on the previous three and is defined with the following actions: the designing of networks, which provide the HCS energy-supply system development; the detection of the generating equipment optimal number on the territory with taking account of the needs; the effective placement of the generating equipment model development; the management of the HCS energy-supply system algorithm creating; the calculation of the cost efficiency indicators; the assessment of the system departure from the given development stage; the designing of the correcting actions for the departing factor lowering.

Thereby, this strategy of the development evaluation of the HCS energy-supply system can be used for any branch of economics on the particular territory.

The described above strategy is directly connected with the model of the development management of the HCS energy-supply system, presented on the Figure 3.

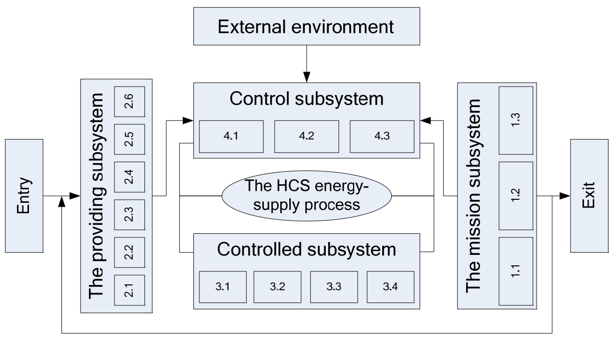

Figure 3. The model of the management of the HCS energy-supply system

We revealed the constituents of every presented subsystem. Under the mission subsystem (1) we understand the set of missions, in compliance with which the management of the HCS energy-supply process is realized. Every mission has its own evaluating mechanism of achievement. The feedback allows evaluating and regulating of the managerial mechanism by timely correcting actions. The mission of subsystem includes: the maximal use of electric and heat energy with the minimal expenses (1.1), the development of the HCS energy-supply system (1.2), the adaptation of the system to the external environment (1.3).

The providing subsystem (2) includes the methodological support (2.1), information support (2.2), legal support (2.3), financial provision (2.4), staffing (2.5), and organizing-technological support (2.6).

The controlled subsystem (3) includes marketing research (3.1), the HCS objects of energy-supply (3.2), the creation of electric and heat energy (3.3).

The control subsystem (4) includes the control of the HCS energy-supply (4.1), the development and the acceptance of managerial decisions concerning the development of the HCS energy-supply system (4.2), the coordination of the arrangements, which concern the realization of the managerial mechanism by the HCS energy-supply system (4.3).

It is necessary to note that the both worked out strategy of the HCS energy-supply system development evaluation and the model of the management of the HCS energy-supply system are the recommendations for the Samara region HCS energy-supply system development with a purpose of the heat and electrical energy cost price lowering by energy conservation.

References

Bilik, P., Kvapil, J., & Misak, S. (2011). Efficiency and internal power flow of renewable power supply system. *Source of the Document Proceeding of the International Conference on Electrical Power Quality and Utilisation, EPQU, 2011* (pp. 248-251). http://dx.doi.org/10.1109/EPQU.2011.6128943

Coslovich, L., Pesenti, R., Piccoli, G., & Ukovich, W. (2008). A model for setting and validating sale prices of an electricity trader by means of load shifts. *International Journal of Energy Sector Management, 2*(3), 351-367. http://dx.doi.org/10.1108/17506220810892928

Edwards, J. S. (2008). Knowledge management in the energy sector: Review and future directions. *International Journal of Energy Sector Management, 2*(2), 197-217. http://dx.doi.org/10.1108/17506220810883216

Fehrenbach, D., Merkel, E., McKenna, R., Karl, U., & Fichtner, W. (2014). On the economic potential for electric load management in the German residential heating sector - An optimising energy system model approach. *Energy,* 263-276. http://dx.doi.org/10.1016/j.energy.2014.04.061

Madlener, R., & De Doncker, R. W. (2009). Investinginpowergeneration. *Handbook Utility Management,* 281-310.

Melnik, A. N., & Mustafina, O. N. (2013). The Organization of Russian Power Market in Modern Conditions. *Middle-East Journal of Scientific Research, 13*, 91-94.

Moore, M. C. (2009). The role of energy efficiency in electric power systems: Lessons from experiments in the US. *Handbook Utility Management,* 761-777. http://dx.doi.org/10.1007/978-3-540-79349-6_44

Sanchez, V., & Ramirez, J. (2011). Optimization of a stand-alone generating system. *Source of the Document Proceedings of the IASTED International Conference on Power and Energy Systems and Applications, PESA,* 163-169.

Sato, E. K., Kinoshita, M.,Yamamoto, Y., & Amboh, T. (2009). High efficiency multilevel uninterruptible power supply. *2009 IEEE Energy Conversion Congress and Exposition, ECCE,* 3143-3150. http://dx.doi.org/10.1109/ECCE.2009.5316239

Sauma, E. E., & Oren, S. S. (2009). Do generation firms in restructured electricity markets have incentives to support social-welfare-improving transmission investments? *Energy Economics, 31*(5), 676-689. http://dx.doi.org/10.1016/j.eneco.2009.01.015

Copyrights