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Systems Approach to Georgian Power Industry Development and its Management

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Topicality of Research. In fuel and energy complex of Georgia there had been accumulated numerous acute problems. Some of them were arisen with the independence, and some of them were arisen in recent years. If they were implemented in the uniform Soviet space by using principle of the so-called "planned" economy, after the advent of independence, it was become necessary to switch to the market economy.

It was become necessary to develop a new energy policy and the development concept of the industry, work out the strategy for energy independence and security, and introduce a new tariff system based on real costs.

XXI century put the world down against such a new additional challenges, as fight against climate changes, increasing energy conservation and energy efficiency, rapid development of using renewable energy sources and other problems, in solving of which Georgia is naturally involved as a aprt of civilized world.

All above mentioned requires Georgian state of adequate actions that should be based on relevant studies and scientifically justified solutions of the system nature.

The demand for energy in the country is increasingly growing. One of the most significant indicators of the present situation in the country is its energy security. Inadequate resources hinder the country's economic development. Georgia is suffering shortages of electric power resources. Uninterrupted operation of its energy sector is possible only through the import of energy supplies.

It is obvious that in such environment, of high topicality is a systemic approach to the development of Georgia's power industry, search for ways and directions for improving management of the industry, as well as ways to cope with deficiency in energy.

Goal and Objectives of Research. The goal of the proposed research is to reveal the ways and possibilities for the development of Georgian power industry and maximal increasing the level of energy supply, and to ensure its scientific justification, as well as improving the industry management. In order to reach this goal, the following objectives were set during the process of this research:

- Analyzing the positive and negative aspects of electric power market in Georgia;
- Studying the role and importance of power industry in the conditions of market economy;
- Evaluation of the country's energy policy;
- Forecasting of electric power generation and consumption in Georgia (monthly and quarterly) by using mathematical models and methods;
- Determining power generation volume in Georgia by using mathematical methods and models.

Main Results and Novelty of Research. The proposed dissertation work represents one of the first research, which envisages comprehensive formulation of a systems approach to the development and management of Georgian power industry:

- Substantiated the increasing role and importance of power industry for Gergian economy in the conditions of market relations;
- Determined the modern development trends of Georgian power industry;
- Studied the power balance, in which advanced rate of development of the production as compared with the consumption, ensures significant increase in electric power export;
- Determined the energy efficiency dynamics in the country, as well as measures for its improvement;

- Developed the proposals for improving management of industry. To that end, the principle of mathematical modeling was used. Built up the production function, by using of which there is calculated the amount of required electric power generation.

Theoretical and Practical Bearing of Research. The proposed research has both theoretical and practical bearing. From theoretical standpoint, the importance of this research is highlighted by fact that with regard to Georgia the mentioned problem is not studied yet at a proper scientific level, and the proposed work is a kind of author's effort to fill this gap.

The results of the proposed research can be used by any legal entities and natural persons interested in energy provision problems; they also can be used by researchers of state institutions and appropriate industries for teaching the following disciplines: Energy Management, Energy Business and Energy Economics.

The research dwells on such practical issues, knowledge of which is necessary for specialists engaged in this field, but for all educated citizens. It may help the reader to develop skill of better adaptation to in-system changes in the conditions of market economy.

The proposed research will serve well to all persons interested in foundations of energy economics and management.

Author's contribution. The authors of significant scientific works related to the development and management of Georgian power industry are as follows: G. Arabidze, G. Chogovadze, D. Mirtskhulava, D. Chomakhidze, E. Baratashvili, E. Julakidze, V. Gurabanidze, T. Gvelesiani, T. Khomeriki, I. Tsereteli, K. Charkviani, M. Gudiashvili, N. Kikodze, N. Samsonia, O. Zivzivadze, R. Abesadze, R. Arveladze and others.

In the works of mentioned authors, there are studied the issues of energy and management development with a view to various stages,

mainly for the conditions of planned economy, but in the majority of them there is no the modern systems approach to the development, and the issue of management in the industry may be said is not studied at all.

Since 2010, the author is actively engaged in reviewing energy-related problems. During this period, she has published 6 scientific articles and participated in 5 international conferences. The works of the author are mostly devoted to the core issues of energy development, which is actively responded to the modern topical energy problems.

Approbation of Work and Publications. Basic provisions, suggestions and recommendations of the proposed work are published in peer-reviewed journals and proceedings of scientific-practical conferences. Considerable part of recommendations had been presented and discussed on scientific-practical conferences and scientific journals.

For the purpose of periodic evaluation and monitoring of works carried out by doctoral candidate, there have been conducted twice (on 15 February, 2014 and on 20 February 2013) the colloquium. The approbation of work (preliminary defense) was held at the Department of Business Administration of the Faculty of Law and Social Sciences on 15 September, 2014.

Volume and Structure of Dissertation. Dissertation comprises 157 computer printing pages. It includes Introduction part, four chapters, 13 paragraphs, conclusions and list of references. The structure of work has the following form:

Introduction

Chapter 1. Management and its Peculiarities in Power Industry.

1.1. Theoretical aspects of management and administration;

1.2. Management in Power Industry

1.3. Management of Power Supply System

Chapter 2. Development of Georgian Power Industry at the Present Stage

2.1. The role and importance of power industry in the country's economic system;

2.2. Factors and preconditions of the development of power industry business;

2.3. Problems and prospects of Georgian power industry.

Chapter 3. Systemic Changes and their Improvement in Power Industry Business

3.1. Economic reforms in power industry

3.2. State regulation as a prerequisite for the development of industry

3.3. The bases of effective regulation of power industry.

Chapter 4. The Main Directions of Systems Approach to the Industry Development

4.1. Conceptual and methodological bases of power industry policy;

4.2. Determining the power industry business strategy

4.3. Improving the management of electric power generation-consupmtion;

4.4. Forecasting of electric power generation-consupmtion by using of Holt-Winters and autorgressive models.

Conclusions

References

Brief Content of Dissertation. The first Chapter of dissertation "Management and its Peculiarities in Power Industry" describes in detail the necessity of improving the management processes in

modern conditions, where the main structure, methods and other components of management system acquire the more complex look and there occurs deeper differentiation of them. This chapter also dwells on the main aspects of systems approach to management, in particular, to system elements, systemic-structural, systemic-functional, systemic-integrative, systemic-communicative and systemic-historical stages.

It has been quite a long time since the country has linked its future with the market economy, but the market implies a complex and full of surprises economic relations, where it is impossible to be successful without proper management.

The issue of management is of essentially importance for energy sector, which is characterized by the following specific features:

1. Power industry is a sector of the economy, which is characterized by high intellectual labor intensiveness and capital output ratio;

2. This sector requires intensive and continuous financing for keeping the functioning capacity, and and the same time for making further progress;

3. In contrast to other industries, energy sector has a big socioeconomic responsibility;

4. As a typical representative of natural monopoly, it requires the state regulation;

5. It is necessary to attract significant amounts of additional investments is essential.

On of the main characteristics of electric power as a product consists in fact that its generation and consumption occur simultaneously that is associated with a quite complex high-tech process. Full cycle of electric power generation and consumption comprises sev-

eral stages: electric power generation by electric power plants; transmission of generated electric power through high-voltage network; its distribution through low-voltage network and its supply to final customer for consumption for domestic or industrial purposes.

Energy consumption cycle comprises three main processes: energy generation, its transportation-distribution for customers and consumption. All three processes are characterized by energy losses. Reducing these losses was always the goal of energy companies and customers.

The business-environment of energy company comprises investors, energy consumers, suppliers of fuel and material-technical resources, brokers, business rivals, regulatory bodies, population and different public organizations. The energy business is also influenced by legal framework, market expectations, political, social, cultural and many other factors.

The management functions in energy enterprises, as in the industry of natural monopoly, are performed by the state regulation.

The problem of regulation is of essentially high topicality in the conditions of existence of monopolies and natural monopolies. In this case, state restricts activities of monopolies and excludes those negative results, which reduce efficiency of the production and slow down economic growth and so on.

It should be noted that management in power industry is characterized by some peculiarities, and this follows from its specifics. These peculiarities are concentrated in state regulation of industry, as a main representative of natural monopoly.

Management of Georgian power industry at the national level is implemented by the Ministry of Energy. The management in the Ministry is implemented through the three-level system:

- Minister – Deputy Ministers;
- Departments: Administrative, Legal, Energy, for Legal Provision, International Relations and Investment Projects;
- Divisions within departments: Financial, State Procurement and Material Provision, Business Correspondence, Energy Resources, Investment Projects

Ministry of Energy implements energy policy and develops relationship strategy with energy ministries and organizations of neighboring and European countries for carrying out mutually beneficial activities.

The result of effective management and flexible policy implemented by Ministry of Energy in recent period is an implementation of electric power export from Georgia as well as positive investment activities.

The second Chapter of dissertation "Development of Georgian Power Industry at the Present Stage" describes the role and importance of power industry in the country's economic system. There is substantiated the decisive importance of power industry for societal development; there are considered the factors influencing power industry development and problems and prospects of Georgian power industry.

Electric power is the most universal type of energy. Electrification implemented on its basis is considered as a source of the country's wealth and strength. It generates high economic efficiency in the industry, transport, rural economy, in housing and utilities and in any other sector.

The development of the history of humanity proved crucial importance of power industry for societal development. Even small failures and crises in this sector create very great danger for the development of all world civilization. The striking examples of this are

the energy crises occurring periodically in the world. It was clearly evident during the period after the 1990s in Georgia.

The development of Georgian power market was always behind the growth rates in power demands. During the first years of independence, Georgia had not been able to ensure autonomous energy provision of its economy.

Without appropriate development of power industry it would be no realistic not only implementation of any socioeconomic program of the country, but the danger will be created for the State system as well. The leading sector of energy complex – the power industry – is vital vein of the complex economic organism.

The more useful is expansion of the power consumption sphere, the more dangerous for the country's socioeconomic development is its reducing. It was clearly evident during the first years of state independence of Georgia (1991-1995). Starting from the years of 1990 in Georgia, power generation and consumption reduced significantly.

Among preconditions for power industry development, one of the main economic factors consists in existence of human resources and energy personnel. During the complex and long period of its development, there was created a considerable labor potential in Georgia.

Among those numerous challenges, which must be solved in present Georgia, of essential importance is the reliable and safe energy provision of the economy. To solve such a complex problem, first of all it is necessary to ensure continuous expansion of own natural energy resources

Energy is a strategically important sector of the economy. Its development rates and scales largely condition the country's economic strength and security. The leading branch of the country's fuel and energy complex is power industry, by development level of which

there are defined the degree of the country's electrification as well as its impact on any sphere.

Today, the development of electric power complex is of essential importance for economic development of Georgia. Strategy of effective use of energy resources should become a basis for intensification of Georgia's economy.

In the years of 1981-1990, electric power generation in Georgia was frozen almost on the one level, while its consumption was relatively rapidly growing – by 500 mln kWh per years on average. In 1990-1997, reduction in electric power generation in Georgia was 49,7%, and consumption –53%.

But there was no continuing the work like that indeed. The industry required implementation of radical economic reforms. Creation of Georgia Energy National Regulatory Commission (GERC) in 1997 was the most important component of a complex process of the economic reforms in Georgian power industry. The development of electric power complex is of essential importance for economic development of Georgia. Strategy for effective use of energy resources should become a basis for intensification of Georgia's economy.

Positive shifts in Georgian power industry are present in general in the period after the year of 2005. Since this time, power generation was increasingly growing with every passing year.

Table 1

Electric Power Generation in Georgia in 2000-2013 (mln kWh)

Years	Genera-tion, total	including		Per capita (kWh)
		HPPs	TPPs	
2000	7446,0	5905,6	1540,4	1691,7
2001	6942,0	5571,5	1370,5	1577,2
2002	7045,0	6532,1	513,5	1611,7
2003	7163,0	6527,9	635,1	1649,5
2004	6706,0	5892,8	813,2	1554
2005	7100,6	6070,0	1030,6	1643,1
2006	7425,4	5321,6	2103,8	1685,8
2007	8169,5	6724,5	1445,0	1858,9
2008	8279,1	7053,6	1225,5	1889,2
2009	8278,3	7314,6	963,5	1887,6
2010	9919,2	9263,3	655,9	2235,8
2011	9912,2	7788,7	2123,4	2201
2012	9471,9	7122,1	2349,8	2114,0
2013	9860,6	8163,5	1697,1	2199,2

Export of electric power is expected to be grown even larger in the near future. This is conditioned by currently carried out massive construction of hydro power plants and power transmission lines, as well as increasing energy efficiency.

Table 2

Electric Power Import-Export in Georgia (mln Kwh)

Years	Import	Export
2000	599,5	204,6
2001	1312,7	4,4
2002	728,0	244,5
2003	1065,8	231,6
2004	1287,1	70,5
2005	1398,6	121,8

2006	777,5	96,1
2007	433,2	625,4
2008	649,0	679,5
2009	254,8	749,4
2010	222,1	1524,3
2011	471,0	930,6
2012	614,6	528,2
2013	484,1	450,4

Based on the electric power generation potential, Georgia is able to increase export volume of electric power by 6.7 times by the year of 2020. High energy tariffs in Turkey and possibility of inexpensive power generation in Georgia lay foundations for increasing export of electric power in the future.

The third Chapter of dissertation "Systemic Changes and their Improvement in Power Industry Business" dwell on studies and analysis of economic reforms in power industry; there considered the issues of state regulation of industry; it has been noted that regulation may be considered as a certain for of intervention by the state, which enforces the monopoly businesses to change their market behavior for maximizing social well-being; there is also substantiated the necessity of making transition to the market economy.

The same Chapter also describes the necessity of state regulation of industry, including the bases for the effective regulation of power industry; in the conclusion made on the basis of this research, there is expanded the idea that the aim of introducing competitiveness in power industry is to create such a reliable management system, which mostly should serve the interests of customers.

The positive trends in the development of power industry in recent years are associated with the economic reforms implemented in indudtry. First of all, it relates to creation of Regulatory organ, implemented privatization and formation of the electric power market.

The main goal of state regulation of the economy is to ensure economic stability, efficiency and justice in the country.

An important condition for successful regulation of the economy consists in independence of regulators. Publicity of regulatory bodies as well as their independence can strengthen confidence of different interested parties and population to this body. Correct state regulation of natural monopolies is an effective way for attracting investments in industry.

The sectors of natural monopolies in Georgia are regulated Georgian National Energy and Water Supply Regulatory Commission (GNEWSRC).

The necessity of GNEWSRC is especially revealed in the isssues related to tariffs. Despite fact that over the past period, the tariff growth considerably exceeded growth in incomes of people, it should be especially noted that tariff would be even higher without regulation. Besides, it should also be noted that GNEWSRC is obliged to protect the legal interests of energy generators and suppliers.

Some countries through the world have developed the opposed deregulation process for energy sector. The necessity of reducing regulation is explained by the following factors:

1. Strengthening competitiveness throughout the world;
2. Development of novel technologies;
3. Abandoning regulation of network-type industries.

The main goal of reducing energy regulation in the world is to increase efficiency of industry by way of promoting competitiveness.

The main way for resolving numerous economic and technical problems accumulated in Georgian electric power system is a sound privatization and attracting the local and foreign strategic investors for this purpose.

Out of those emergency measures should be taken in industryo of essential importance are as follows:

- Continuation of policy of economic reforms established by the country. In particular, improving regulation, strengthening privatization, perfection of tariff policy and so on;
- Resolving the problem of domestic receivables and payables;
- Introducing real electricity tariffs and canceling any preferences for payment of electric power costs;
- Creation of energy development fund from the part of receipts from privatization.

During privatization of power assets, special attention is attached to the country's energy security. Successfully implemented privatization may contribute to both state budget balancing and strengthening the tax balance.

The fourth Chapter of dissertation "The Main Directions of Systems Approach to the Industry Development" refers to determining strategy in energy sector and defining the ways for improving management of electric power generation and consumption. It dwells on studies of conceptual and methodological bases energy policy, there are also considered the main direction of perspective development and forecasting parameters of Georgian economy, as well as the issues related to management of electric power generation and consumption.

The main goal of a policy implemented in energy sector of Georgia consists in maximal development of energy resources existing in the country and complete meeting of demands for energy resources.

One of the main goals of energy policy consists in ensuring the country's energy security. In the XXI century, we should abandon still existing in Georgia inclination to the wasting consumption of energy, and the issues related to increasing efficiency of energy

generation, consumption and servicing should be brought to the forefront.

For strategic planning and management of energy companies, there are recommended the measures as follows: creation of development council; making strategic solutions in practice; formation of specialized divisions.

The main objectives of Georgia's energy strategy much differ from the positions of those countries, which possess a certain amounts of organic fuel of their own production. The problem of reducing high energy intensity of national economy pertains to the category of the most important goals of energy strategy of Georgia.

The current tendency of economic improvement creates obvious prospects for growing demands for the country's energy resources, and they require to be resolved under the strict conditions of market relations.

Rational use of energy is of essential importance for Georgia as a dependent country, where the most part of resources is is imported from outside.

Management of customer demands in energy sector is being implemented within the customer demands management programs (CDMP). These programs envisage the following:

- Based on energy audit, to reveal the possibilities of energy saving and reducing energy inputs for customers, and developing appropriate recommendations for them;
- Compensation of those costs that should be borne by customer for purchasing the energy efficient equipment, devices and materials;
- Developing such policy of differential tariffs, which should encourage energy consumers to meet their demand mainly during the period of non-peak load.

Electric power generation and consumption in the modern world reflects the technological development quality of a particular

country, the level of people's freedom, quality of their life and environmental protection. At present, in the world there is a trend of slowing down of energy resources growth rates, on the one hand because of exhausting the reserves, and on the other hand due to reducing demands.

Forecasting of the objective of electric power generation in Georgia is a complex process itself. For yielding short-term prediction, we have used the Holt-Winters model, which is an adaptive model with a seasonal component. The Holt-Winters model is a mathematical model, which allows making evaluation and prediction of quarterly data. By processing of monthly data, it is possible to develop the model more approximate and close to reality, in order to make a maximum possible accurate prediction, but this is possible by using autoregressive model.

By the result obtained by using Holt-Winters model, the yearly power balance of Georgia will be debt-neutral by 2014 (+229,0 mln kWh), but in seasonal balanace deficit is anticipated in I and II quarters.

One-month prediction obtained by using autoregressive model (August of 2014) is compared with real data available on the official web-page of the electric power market operator. The obtained difference is only 28 kWh that enables us to say that the model is adequate, but the obtained results are optimal.

The following conclusions flow from the results of the proposed research:

1. Geographical location is a large potential for the development of Georgian power industry. Along with reliable energy provision, it provides the cost saving in electric power generation, macroeco-

nomic advantages, reforms of energy sector and possibilities of participating in the European Union internal market;

2. In Georgia, there is a tendency of increasing energy efficiency with a view to both energy intensity and energy losses;

3. The most important component of power industry strategic development is an increase in energy efficiency. It is well-known that in the twentieth century throughout the world, including Georgia, the organic energy resources were intensively involved in economic circulation. This resulted in exhaustion of traditional capacities of the electric power base. In the XXI century, the former structure of electric power generation and consumption should be changed necessarily.

4. Of high importance is introduction of energy efficient technologies in Georgian power industry. There is substantiated one of the most topical today's problems – energy efficiency.

5. There is determined the essence of management of public demand for energy, its peculiarities in industry and everyday life.

6. The dissertation dwells on the idea that the role of management, as a specific type of human activities, is of particular importance in power industry. This is conditioned by fact that this sector is characterized by peculiarities: first, among other economic sectors, it is distinguished by high intellectual labor-intensiveness and capital investments; secondly, the industry requires intensive and continuous financing for keeping the operating capacity, and, at the same time, for making progress in compliance with the requirements of macroeconomic environment; thirdly, in contrast to other industries, energy sector has a great socio-economic responsibility; fourthly, as a typical representative of natural monopoly, it must be regulated by state; fifthly, it is necessary to attract considerable amounts of

additional investments, and as a result of the integrated influence of other objective factors (ecology, the necessity of developing increasingly raising in price energy resources, etc.), this further increases capital intensity of industry, and consequently the risk is higher.

7. This study showed that the more useful for the society is expanding the field of electric power consumption, the more dangerous and destructive is its reducing for the country's socioeconomic development. During the period of transition to the market economy, electric power generation dropped to the level of 26 years earlier. This fall in generation resulted in reducing of net national product to the level of 33 years earlier. Industrial production was reduced to the level of 36 years earlier, and agricultural production to the level of 49 years earlier, rail traffic - to the level of 54 years earlier, and social labor productivity dropped to the level of 33 years earlier.

8. The analysis of Georgian power industry development during transition period, in particular during the years of independence, showed that electric power generation and consumption in the years of 1990-1997 was reduced by 50% approximately. The production performance worsened as well. At this time, the energy system of Georgia had to operate under the non-traditional conditions. Financial provision of industry was extremely low, and managerial activities were unsatisfactory.

9. The situation was relatively improved since 2000, especially after the yaer of 2007, when the power balance of Georgia became debt-neutral. During the period of 2000-2013, electric power generation in the country rose 32,4%, including HPPs – 38,2% and TPPs – 10,2%. By the end of studying period, electric power generation reached 9860,6 mln kWh, including HPPs – 8163,5 kWh and TPPs – 1697,1 mln kWh.

10. Positive tendencies in power industry development achieved in recent years are associated with economic reforms implemented in the branch. First of all, this relates to creation of regulatory body, implemented privatization, and formation of electric power market. The dissertation dwells on the analysis of positive and negative results of each of them; there are developed the measures required for their improving. The proposed work describes state regulation as a prerequisite for the development, and consequently there are formulated the principles of effective regulation.

11. There are presented conceptual and methodological bases for energy policy. To ensure reliable and safe energy provision it is necessary to carry out the following activities:

- Wide use of energy resources existing in the territory of Georgia with a view to complete compliance with environment protection requirements; both hydro and thermal capacities, as well as other alternative energy sources should take their proper place;
- The essential role in normal energy provision of power industry should be played by economic and rational consumption of energy;
- Georgia has to establish reliable and beneficial international energy-related relations with world's leading countries, especially with neighboring states;
- Sustained attention should be attached to improving the industry management and implementing economic reforms.

12. In dissertation there is made short-term prediction of electric power generation and consumption for the year of 2014 by using the Holt-Westers model by each quarter. The results of calculations (,ln. kWh) are as follows:

Quarter / Year	Generation	Consumption	(+) (–)
I quarter	2131,5	2357,1	-225,6
II quarter	2278,1	2373,8	-95,7
III quarter	2799,3	2512,8	+286,5
IV quarter	2952,0	2688,1	+263,9
Yearly	10160,9	9931,9	+229,0

Thus, the yearly electric power balance of Georgia by the year of 2014 will be debt-neutral (+229,0 mln kWh), but the deficit by seasons is anticipated in I and II quarters.

For prediction of electric power generation, the dissertation dwells on using autoregressive model as well. Prediction for one particular month (August of 2014) made by using autoregressive model is compared with a real data available on the official web-page of the electric power market operator (http://www.esco.ge/index.php?article_id=111&clang=0) and the obtained difference is only 28 kWh that enables us to say that the model is adequate, and the obtained results are optimal.

The main provisions of the proposed work are mostly published in the following editions:

1. Power Industry Development in Georgia at the End of 20th Century and at the Beginning of 21st Century; Collection of scientific papers. Topical scientific research. From theory to practice. Warsaw, 2014.

2. Management Peculiarities in Power Industry. Scientific-theoretical and industrial journal "Topical Problems of Economics, Sociology and Law". Stavropol Teritory, Pyatigorsk, 2014.

3. Systems Approach in management System; International Scientific-Prcatical Conference. Kutaisi, May 24-25, 2013.

4. The Place and Role of Management in Power Industry. International Scientific-Prcatical Conference Kutaisi, May 24-25, 2013. Subject: "Energy: Regional Problems and Development Opportunities".

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11. Energy Audit – a Modern Innovation in Georgia. Periodical scientific journal "Goni", № 1. Kutaisi, 2014.