INTERACTIONS BETWEEN ENERGY SAVING PROGRAMS AND ENERGY RESOURCES CONSUMPTION MONITORING SYSTEMS

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Introduction: In order to meet the growing demands of people for services and goods, the impact of humans on ecosystems is continuously increasing which will inevitably lead to increased consumption of natural resources, including energy sources, environmental pollution and social tension. Therefore, the need for sustainable development and changes in the relationship between human and nature, as well as between people, is undeniable. An example of such changes is the increasing manifestation of people's energy-saving behavior. At the same time, modern global economic challenges set new goals and problems for improving legal and organizational measures for ensuring economic competition and development. At the same time, it is possible to ensure the solution of problems only if those negative factors of the economy, which objecttively hinder the development of competition and economic growth, are overcome. In recent years, the RA economy has faced economic challenges that were caused by both external and internal military and political factors. Structural shifts in the economy, including in energy sphere are happening more and more rapidly, their presence affects all processes, including political and social.

Methodology. The following research methods served as the basis for scientific research: empirical research methods: observation, comparison, measurement, methods used both at the analytical and theoretical stage of research. Econometric, statistical, factorial, system analysis methods were used in of analysis as well as grouping and economic-mathematical methods were used for Scientific novelty proposal. The theoretical and methodological basis for solving the study tasks are the main provisions of classical and modern theories of economics, the works of domestic and foreign researchers, legislative regulation of the sphere and by-laws.

Literature review. There is literature with energy, exergy, economic or environmenttal types of objective functions of energy consumption systems. Economic analysis

for example, minimizes the investment cost or the total annual cost for a system at the optimum point [Sanaye & Khakpaay, 2022, 1]. There are some partial systems of indicators used by separate programs for evaluation energy-efficiency programs on basis of methodologies of international organizations such as UNDP.

Scientific novelty. There is no scientific developed complex and unique system of energy-resources consumption monitoring in RA. This paper proposes an innovative combined multi-objective complex of indicators and mechanism for their calculation for energy consumption monitoring.

Analysis. Digital transformation is one of the main factors of global economic growth at the current stage. The changes currently taking place are so significant that they can be described as the greatest technological transition in history, when the abundance of natural resources and cheap labor cease to be the main factors of growth. The rapid changes taking place in the field of digital technologies present a challenge and a threat to the participants involved in the energy processes. New, previously non-existent products for the energy sector and services in the energy sector are appearing on the markets, the use of which was previously not possible for consumers and was not subject to state control [2]. Under these conditions, competition is the main factor that can ensure economic growth in the energy sector. The direct impact of digitization processes in the field of energy is manifested by energy saving and energy efficiency, which are a priority for all countries and lie in the cornerstone directions of science and technology development, without which it is difficult to imagine the vision of ensuring sustainable economic growth of countries. The energy sector is the main resource consumed by industry, transport, urban development, households and the main source of greenhouse gas emissions. Therefore, the transformation of energy systems is a priority and is an integral part of measures to combat climate change. Therefore, developing appropriate regulations and incentives for sustainable and renewable energy can provide key potential for climate change adaptation and carbon reduction also in RA. National energy saving programs of the countries are aimed at increasing the efficiency of resource use, modernizing existing infrastructures, identifying measures to protect the environment and, as a result, improving the country's energy security. In addition, national energy saving programs and their successful implementation is one of the main prerequisites for building the "green economy" of countries. They must reflect the country's economic priorities, be realistic and feasible, be enable updates and improvements; be financially attractive [Macknick, 2012, 2]. Its implementation should be implemented with the following cyclic scheme.

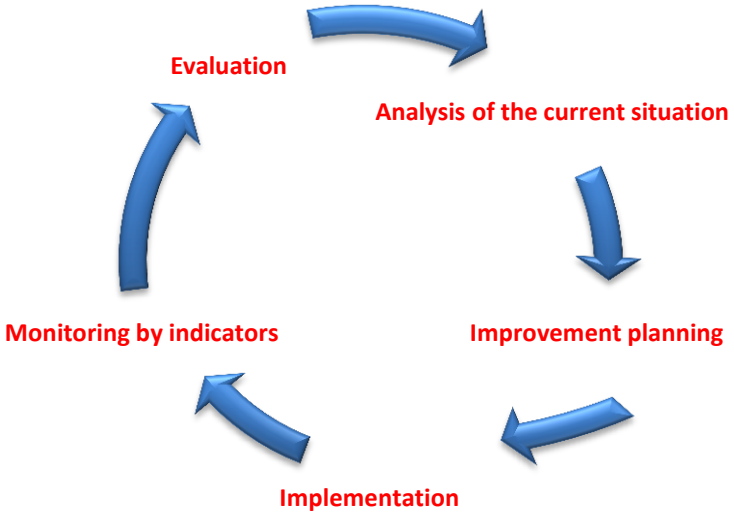

Chart 1. Implementation should be based on the GCAP methodology in energy saving programs

The Energy Saving and Renewable Energy Program for 2022-2030 of RA was developed based on the provisions of the strategy of the development of the energy sector of the Republic of Armenia (until 2040) approved by the decision of Government of RA N48-L of January 21, 2021. During the development of the project, the commitments undertaken by the Republic of Armenia in the framework of various international agreements and documents in the directions of sustainable development, renewable energy, energy saving and climate change were also taken into account. At the same time, program regulates the relations related to the policy directions, goals and targets in the fields of energy saving and renewable energy for 2022-2030, as well as the main actions and measures planned in the direction of ensuring the set targets.

According to the RA National Energy Saving Program 2011-2018, energy intensity in Armenia has been improved by an average of 2.5 percent annually, compared to an average annual improvement of 2 percent at the global level during the same period. The National Energy Saving Program aims to improve the energy efficiency of Armenia's economy and encourage energy saving over the next ten years, as well as to expand the use of renewable energy sources as a means of increasing energy security and reliability and reducing the negative impact on the environment. The National Energy Saving Program considers the provision of primary energy supply and the provision of specified levels of final energy consumption as key targets. The main target of final energy consumption is considered to be the target size for the whole economy, while the sectoral

targets will be indicative in nature [Energosovet, URL portal,4]. It should be noted that energy saving indicators are classified into the following groups:

a) indicators of behavior change that lead to a reduction in energy demand;

b) indicators related to the improvement, replacement or modernization of the used equipment and systems, infrastructures [Tsapenko, 2007, 3].

From the point of view of economic efficiency, the target energy efficiency is the increase in the consumption of energy resources in case of progressive growth of GDP.

In addition to the main targets, the energy saving program sets targets in the following two directions:

1) development of renewable energy as source of cheap energy resources,

2) energy saving.

The first direction assumes that there will be significant shifts in the structure of electricity production volumes. If in 2000 RA in the volume of electricity production the share of power from thermal stations was 45.2%, renewable energy was 6%, then in 2021 respectively: 35.9% and 12%. Electricity production and consumption in 2000-2021 shows a growth trend. At the same time, as can be seen from chart N2, the share of renewable energy is steadily increasing and the economic, social and environmental viability of renewable energy is increasingly emphasized, contributing to the neutralization of risks in the energy sector, the opening of green markets and the creation of a favorable environment for investors, which is also could be supported by application of consumption monitoring systems of energy resources.

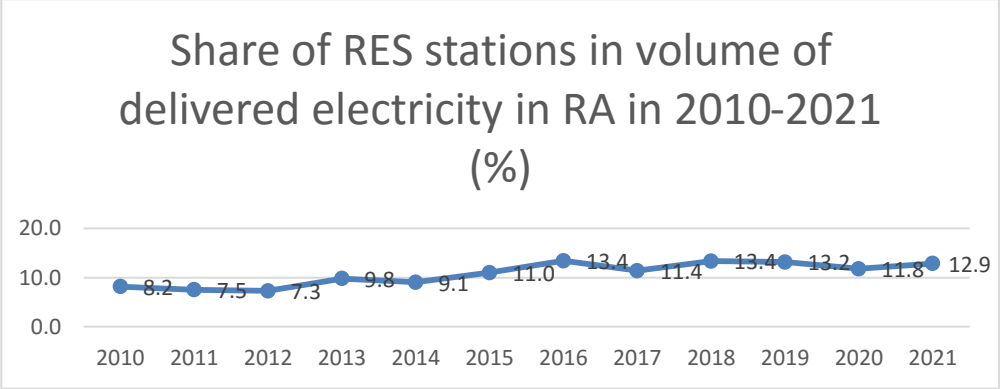

Chart 2. Share of RES stations in volume of delivered electricity in RA, 2010-2021 (%)

Source: Official site of Public Services Regulatory Commission of RA (chapter Reports)

Besides abovementioned commercial RES projects in RA are widely developed autonomous producers. As of 01 January 2022, 6940 autonomous solar energy producers are connected to the "Electric Networks of Armenia" with a 136083.97 kW total capa-

city. An additional 518 with 11499.58 kW total capacity is in the process of connection. Individuals and businesses can install up to 150 kW solar power stations, produce electricity for internal consumption, and sell the surplus to "Electric Networks of Armenia".

As can be seen from chart 1, one of the keys to the successful implementation and improvement of energy saving programs is monitoring according to indicators. In RA, we suggest using energy resource consumption monitoring systems in all energy saving programs implemented with budgetary or grant funding, introducing real-time monitoring systems of energy consumption at all levels of consumption. The efficiency of energy consumption monitoring systems and energy saving measures in general are determined also by used software and its functionality, which allow both to automate the main production processes and to simplify information flows, to ensure the most complete processing and use of primary information and to implement complex information procedures supporting the adoption and implementation of strategic and tactical management decisions [Energosvet, URL portal,3]. In order to achieve this goal, it is necessary to solve following problems in the design of energy consumption monitoring systems:

- development of a methodological basis for the creation of monitoring systems, indicator systems and information processing and decision-making support methods, statistical and analytical algorithmic base,
- development of the general architecture and structures of individual specialized functional elements of the software security system,

The goal of monitoring systems for energy saving measures and projects in separate sectors of the economy is first of all qualitative and quantitative assessment of the level of implementation of energy saving programs and forecasting their dynamics, as well as a comprehensive assessment of the state of energy saving and energy consumption, presenting also the sources of energy resources cost optimization [Energosvet, URL portal, 3]. Moreover, the main task of developing the methodological basis of the monitoring system in separate sectors of the economy is the development of the system of monitoring indicators, which must meet the following requirements:

1. Since the developed monitoring systems provide monitoring not only of individual energy saving measures and projects, but also of the sectoral energy saving program as a whole, the system of these indicators should make it possible to assess the impact of the results of individual projects on the whole program as a whole.

2. 3. Indicators of energy resource consumption monitoring should provide an opportunity to evaluate the main indicators of energy saving.

4. The structure of the system of indicators should correspond to the structure of the considered process and express all the functions performed during the process, which are defined by management goals and, if necessary, give a complex and multifaceted assessment of the processes.

The indicators included in the hierarchical monitoring system are divided into the following of main groups: technical, organizational, economic, where the aggregated indicators for the most comprehensive level measures are determined based on the primary indicators.

Taking into account the fact that the consumption of electrical energy in production and administrative areas is inevitable for companies in all sectors of the economy, the approach to developing the methodical base for energy saving and energy consumption monitoring proposed in this work can be applied in all sectors and organizations of the economy. Thus, the weighted average cost of an energy resource for per unit in a separate company (object, sector of the economy) can be determined by the following formula:

$$Cr = \frac{\sum_{k=1}^{n}(\mathrm{C} * \mathrm{t} * \mathrm{P^r} * A^M * \mathrm{L} + \mathrm{IM} * \mathrm{t} * \mathrm{P^r})}{\mathrm{V} * \mathrm{Lr}}$$

where

C is the capacity **po**wer of k^{th} equipment (kW);

t is the working time of the k^{th} equipment during the given month (hours),

A^M is a coefficient that takes into account the difference between the external and internal average temperatures in a given month,

L is a coefficient that takes into account the level of depreciation of energy resources' consumer-equipments,

IM is the additional power to bring the idle equipment into mode,

P^r is the cost (price) of the energy resource (Drams),

V is the surface area (volume) of the object where the consumer-equipments are located (m^2)

Lr is a coefficient that takes into account the losses of energy, which is calculated based on the average designed and actual load of consumer-equipments.

Thus, when developing a system of monitoring indicators, it is necessary to form a rational composition of the most informative indicators and make rational decisions based on them.

And the coefficient characterizing the cost level of energy efficiency can be calculated as follows:

$C_{ee}=\frac{Sn}{V}$, where,

C_{ee} is the coefficient characterizing the cost level of energy efficiency,

Sn is net energy savings

V is the sum of the cost of electricity consumption in the economy, the investments directed to energy saving measures and the cost of state support programs. It follows from the formula that the amount of net savings (which represents the differences

in electricity consumption before and after the application of smart systems) directly affects the cost level of energy efficiency.

Thus, it becomes clear that the energy competitiveness of the economic sectors is a powerful factor of economic growth, and the dependence of countries on international energy relations has increased significantly. One of the most important questions in energy efficiency research is what underlies the benefit of energy savings [Energy-saver-guide-2022]. The answer to this question helps to identify net savings for each organization and country and factors that determine the energy consumption structure of the economy.

Conclusion. Energy saving could be not only in result of behavioral change but also as requirement set by legislation or other legal acts or standards and refers not only to reduction of use of energy resources but also to construction own sources of electricity and closely impact on energy security of countries. Two approaches to accounting for net savings can be distinguished.

• calculation of net savings by organizations,

• calculation of net savings according to economic processes. This approach can give a clearer picture of increasing the energy competitiveness of separate spheres of economy, which can be calculated according above mentioned formula proposed be authors.

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Interactions between energy saving programs and energy resources consumption monitoring systems

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In order to face the global economic challenges and achieve the national goals and objectives of RA economic development, a number of large-scale measures are needed to promote the development of competition, as well as the consolidation of efforts aimed at the implementation of the set tasks by all levels of government bodies, sectors of the economy and organizations. The Development of competition in the field of energy can especially contribute to ensuring sustainable growth in the economy, and energy saving programs contribute to the reduction of energy consumption of the economy, development of technologies, reduction of costs in national economy, improvement of the welfare of consumers and increase of the economic efficiency and competitiveness of the activities of business entities. Ensuring energy saving is related both to the reduction of unit costs of energy and to the development of renewable energy. And the effectiveness of energy saving programs is related to the use of monitoring systems for the consumption of energy resources, and their functionality is related to the presence and operation of complex monitoring indicators.

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