Nature-like economy as a sphere of energy-saving behavior of households

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Abstract. This article discusses the author's position on the essence and manifestations of a nature-like economy based on the use of nature-like technologies. The author draws attention to the need to respect the use of energy of all types by households, especially in the context of widespread use of electronic products. The paper notes that the creation of nature-like technologies of various levels should be based on an economic base. Within the framework of logic, the subject and object of research of a nature-like economy are identified as an area of scientific research. In the system of practical activity, energy is identified as the main factor in such an economy, the main participant in the economy is artificially created living systems. And production is based on the use of nature-like technologies. The use of various types of energy is the basis for the functioning of a nature-like economy. Enormous investments are needed to develop nature-like technologies and economies. The article also provides examples of the experience of using nature-like technologies and economies in various countries of the world in order to optimize the use of various types of energy. The article highlights mono and polyfactorial methods of analysis, the scientific basis for studying the actions of households is highlighted. According to the authors, the formation and development of a nature-like economy will affect the change in the thinking style of household members in the field of energy conservation, which will take quite a long time.

1. Introduction

The need to search for new reserves in energy conservation of various institutions of society requires in-depth studies of the advantages of certain types of social and economic devices based on technologies. In particular, at present, there is an impact of the widespread use of electronic products on the growth of energy consumption by households. The so-called "vampire" electronics - devices and devices that spend energy, even when they are not actively used, significantly affect the level of energy saving. For example, a microwave oven consumes energy even when food is not being prepared - it keeps the digital clock running. And even when your computer is "asleep", it is still using energy. Scientists at the Lawrence Berkeley National Laboratory of the US Department of Energy claim that standby energy accounts for 5-10% of household electricity consumption. If you turn off unused devices from the network (TV, VCR, stereo, charger), then this will reduce a significant amount of electricity consumption. According to researchers, cloud-based forms of information storage in the next 10 years can consume about 11 percent of global consumption.

In such an environment, it is necessary to find new reserves in energy saving. It should be noted that in each state a regulatory framework for energy conservation has been created, a large number of
organizational and technological measures will be carried out at the level of the country, regions, industries, organizations and firms aimed at creating conditions for optimizing energy consumption. Despite the efforts made by politicians and business executives and a considerable amount of research and the results obtained, the theoretical and methodological basis for studying energy saving of households on the basis of economic theory has not been created. There is a study of individual manifestations of the energy-saving process of a narrow nature, in particular, the problems of energy conservation management in an apartment building, in everyday life. The fact that energy saving in Russia is based on more than 70 regulatory documents indicates the need for a systematic and integrated approach to studying problems in this area and making scientifically sound decisions to resolve them.

2. Materials and Methods
Currently, in scientific circles and practical activities, the provisions of the innovative economy, the digital economy, and "Industry 4.0" are actively applied. Each of them has its own characteristics of formation and development, and also relies on certain core technologies. Thus, digital technologies are the backbone of the digital economy, and innovative technologies are the basis of an innovative economy. Industry 4.0 is big data.

Natural technologies have also come to the attention of scientists and statesmen. Russia also pays great attention to using the advantages of such technologies. The Strategy of Scientific and Technological Development of the Russian Federation as a strategic priority: "in the long term, research in the field of ... the development of nature-like technologies ..." (strategy of scientific and technological development of the Russian Federation. Decree of the President of the Russian Federation of 01.12. 2016 No. 642 http://kremlin.ru/acts/bank/41449).

3. Results and Discussion
The creation and development of nature-like technologies should be based on a certain economic base and obtaining economic benefits. It should be noted that there is no fundamental research on the content and features of the implementation of a nature-like economy. In contrast to a cyclical economy, a nature-like economy relies on the use of benefits from operations, where natural and natural factors and resources of human and firm life are the beneficiary. The work of Abderraouf Bouakkaz and others considered a hybrid power system [1].

For the purpose of a specific and systematic analysis of the manifestations of the features and prospects for the development of a nature-like economy, it is necessary to give it the following scientific definition. Nature-like economy is a field of scientific and economic activity that considers the behavior of subjects of financial and economic activity in the production and consumption of various types and forms of energy, reproduced using nature-like technologies. Nature-like technologies are based on the use of energy. As for the concept of "energy", it should be noted that there is no generally accepted meaning. The word "energy" itself has ancient Greek roots and is used in the meaning of "active force. A nature-like economy as a theory should have its own subject and object of study (table 1).

| No. | Scientific elements | The content of scientific elements |
|-----|---------------------|-----------------------------------|
| 1   | Subject of research | Economic and technological phenomena or processes associated with energy consumption generated using nature-like technology |
| 2   | Object of study     | A set of relationships (economic, financial, managerial, technological, digital, etc.) that affect the state of consumption and production of energy by nature-like technologies. |

A nature-like economy as a sphere of economic activity is characterized by the following data (table 2).
Table 2. Characteristic features of implementing a nature-like economy in practice

| No. | Elements of a nature-like economy | Content of elements |
|-----|-----------------------------------|---------------------|
| 1   | The main factor in the activities of economic entities | Energy in different types and forms, produced by nature-like technologies. |
| 2   | Production                        | Based on the use of nature-like technologies |
| 3   | The main participant in the activity | Artificially created living systems |
| 4   | Production control and management  | Integrated human-machine systems |

In general, a nature-like economy should be located at the junction of the combination of "living" and "inanimate" aspects of society's activities, which meets the requirements of the development of civilization, and, accordingly, fundamental research in this area of economic science is needed. At the same time, scientific papers note that "computational models based on economic principles and methods are powerful tools for understanding and analyzing energy and environmental problems, as well as for developing policies to solve them" [2]. Other paragraphs are indented (BodytextIndented style).

Energy conservation is one of the many goals of various actors in society and the economy [3]. The energy-saving behavior of a household in a nature-like economy will differ from its behavior in a traditional economy. In recent years, the energy-saving behavior of households has become an object of research by scientists from around the world. Basic approaches to energy demand modeling have been reviewed by Afeees A by others [4]. Among the significant works in recent years, one can single out the study by Mahmoud Salari and Roxana J. Javid on modeling household energy expenditures in the United States [5], Boudet X. and others on clustering energy-saving behavior in the family [6], Ito and Koichiro on the consumption or the average price of electricity [7].

Significant results on attitudes towards energy conservation were obtained based on the analysis of empirical data by researchers in France [8]. In most cases, energy saving is considered not from the point of view of analyzing the behavior of households, but from the point of view of using energy-saving building technologies. So, the behavior of households when buying can be influenced by the level of heat storage on different floors of a multi-storey building [9]. For example, researchers Marlyne Sahakian and Béatrice Bertho have identified the effect of household emotions on both reducing and improving energy use [10].

The energy-saving behavior of households in a nature-like economy should be based on the use of energy that occurs naturally. At the same time, the analysis of the formation of the behavior of households in the field of energy saving depends on the used scientific research base.

Thus, from the point of view of representatives of the neoclassical direction of economic theory, the behavior of households in the use of energy resources is characterized by such concepts as "utility", "benefit", "profitability", "marginal", etc. Energy elasticity is essential for shaping household behavior. It is known that the most stimulating direction in energy saving is getting benefits from energy saving, that is, there is a market model of consumer behavior. In recent years, household consumer spending on electricity has been growing (table 3).

After all, the less a household spends energy, the less it pays for it. If you take an average family with a minimum income level, then the family will certainly save energy in the house. It should be emphasized that in Russia about 15% of households receive income at or below the subsistence level. Conventionally, if in the previous month the family paid about 3-4% of the total income for energy, then after saving and using energy-saving funds it can already be 1.5-2%. The increase in electricity debt is one of the most pressing problems. Turning off the lights on time, good housekeeping and the use of energy-saving lamps in the household can save a lot of energy.
Table 3. The structure of consumer spending by households in the Russian Federation (as a percentage of the total)

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|------|------|------|------|------|------|------|------|------|------|
| Consumer expenses | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| including on electricity, gas and others | 5,5  | 5,5  | 5,1  | 5,1  | 5,1  | 5,4  | 5,6  | 5,4  | 5,5  |
| of them electricity | 1,2  | 1,3  | 1,2  | 1,3  | 1,3  | 1,4  | 1,4  | 1,4  | 1,4  |

A source. The website of the Federal State Statistics Service, https://www.gks.ru

The energy-saving behavior of households in terms of institutional theory is defined by such concepts as "institutions", "rules and regulations", "property", "energy contracts", etc. The economic meaning of the very concept of "institution" is multifaceted. Discussions about the institution are conducted on the issues of its origin, role and evolution.

Of particular importance within the framework of institutional theory is the concept based on the use of a system of contracts and agreements. In particular, households in the field of energy supply can conclude such agreements as an agreement on the supply of electricity, on the provision of services for the development of a list of energy service activities; contract agreement for the installation of energy service equipment; an agreement on the provision of services for the analysis and maintenance of energy service activities, etc. The process of concluding each agreement and energy contract has its own characteristics.

The institutional behavior of households in the energy sector is also influenced by informal norms. Among the problems is theft of electricity. It is also necessary to take into account technical losses, unaccounted electricity consumption. It is also worth highlighting the creation and functioning of institutions regulating energy consumption. Thus, laws, by-laws and other governing rules of the game in the energy sector are constantly reviewed, supplemented, etc. This is especially noticeable in the field of providing energy services to the population. Each year, households are faced with changes in electricity tariffs, billing, etc.

According to the moral and educational concept as a part of institutionalism, the energy consumption of households is related to such institutions as customs and traditions, a careful attitude to energy - heat resources.

The technological concept of energy-saving behavior of households involves the use of modern energy-saving technologies. “Smart home”, “smart city”, “smart grids” are already becoming common concepts. Energy efficient technologies hold great promise for lowering household finance costs. For example, it is no longer a secret for anyone that LED lamps are more profitable than incandescent lamps of the old type. Technologies do not stand still, therefore there are a huge number of devices and systems for energy saving and energy efficiency.But you need a heat pump, that is, a device that transfers heat energy from a heat source to a heat reservoir for subsequent use. An invaluable resource is the thermal energy produced by the human body. So, scientists at the University of Massachut came up with wall paint that could provide a house with energy. In fact, the paint must absorb the energy of living organisms. Assembled the Air-gen device, which extracts electricity from water molecules in the air using bacterial nanowires.

Stockholm Central Station has long learned to use the energy of human heat. With the help of heat exchangers in the station ventilation system, excess heat energy is transformed into hot water, which is subsequently pumped into the heating system of the neighboring building. Thus, the lack of energy resources, as well as their cost, reveal the potential of households to generate their own energy and the possibility of its further distribution for a certain fee.

A nature-like model of energy-saving behavior of households involves the use of modern energy-saving technologies. “Smart home”, “smart city”, “smart grids” are already becoming common concepts. Fang Zhao and others pay attention to the features of the development of e-government and the
digital economy [11]. Energy efficient technologies hold great promise for reducing the financial costs and environmental damage associated with energy use. Technologies do not stand still, therefore there are a huge number of devices and systems for energy saving and energy efficiency. In particular, researchers from the University of Gothenburg have found a way to turn ordinary windows into solar-powered heaters that can significantly increase the temperature of the glass, even in freezing weather. The main functional components of the invention are plasmonic nanoantennas. With the help of plasmons, nanoantennas are capable of intensely absorbing light, which then heats up the entire surface.

The experience of foreign countries, where innovative methods of energy-saving behavior of households are used, is also very interesting. So, in Germany there is a so-called "passive housing". The thermos inside keeps the temperature almost constant for a long time without the need for additional heating or cold. Likewise, in a passive house, the desired constant room temperature can be maintained in all weather conditions with minimal operating costs. Unlike an “active” energy efficient home, a “passive” one prioritizes not generating alternative energy, but minimizing costs. Its energy consumption is 40-90 percent less than that of a typical typical building. Such a house heats itself in winter and cools in summer thanks to high-quality insulation.

In Japan, living curtains and green walls. Energy efficient curtain in Japan is the solution for hot summer and cold winter nights. On a hot summer day, the walls of houses in areas exposed to the sun can heat up to temperatures above the air temperature, and then heated objects will radiate heat into the environment, increasing the heat around them. A plant wall provides shade and cooling for windows and balconies, reducing building wall temperatures by 10 degrees by reflecting direct sunlight. In winter, these green walls can insulate a home and reduce heating energy costs.

In South Korea: tents inside the house. Due to high electricity and heat tariffs, some Koreans sleep in tents. If the temperature in the apartment is 19 °C, then inside the tent the air heats up to 23 °C. Not entirely comfortable, but this allows them to save on heating appliances.

For a deeper analysis of the behavior of households in the field of energy saving, it is necessary to carry out its strategic modeling. On the basis of an economic-mathematical model, the process of energy-saving behavior of households can be used one-factor or poly-factor representations.

The model with one variable factor is based on the use of one of the variables, in particular, an increase or decrease in household income, which most of all shapes the energy-saving behavior of energy users. In the event of an increase in income, households can transform their behavior towards obtaining more benefits from using an additional unit of energy. And vice versa. A decrease in household income contributes to the formation of its economical behavior, for example, they will refuse certain types of benefits.

In multi-parameter mathematical models, the implementation of the influence of external (main and secondary) and internal (main and auxiliary) functions in the energy-saving behavior of households is taken into account.

As you know, external (general object) functions are performed by the object of analysis as a whole and reflect the functional relationship between the object of analysis and the scope of its application (external environment). They reflect the relationship of the object of analysis as a whole with the scope of its application, i.e. with the system of which it is an element. Also reflect the operating conditions (use of the object).

In turn, external functions, according to the degree of satisfaction of a given need, are divided into main and secondary ones.

The main ones are the functions of appointment, the main purpose of the existence of the object as a whole.

Secondary (enriching, opportunistic) functions reflect the side effects of the object, its additional properties.

Secondary functions do not fundamentally affect the performance of the object and reflect either restrictions that must be observed when the object performs its main (main) function, or additional conveniences and advantages. These are functions that provide functionality and usability/
Each variable can be positively or negatively reflected in the rational or irrational behavior of households in energy conservation.

So, external functions, that is, influencing the energy saving process from outside, include:
- the main function (determining the purpose and meaning of energy saving), for example, changing prices for energy resources or introducing a tax on income received as a result of energy saving in households;
- minor functions (affecting the actions and interconnections of the elements of the energy saving system), for example, the use of outdated house infrastructure of power grids, an increase in the number of used gadgets.

Internal functions of energy saving in households, that is, influencing the process of energy saving from within the energy saving system, include:
- basic (target settings in energy saving of family members), as using the principle "when leaving, turn off the light";
- auxiliary (for example, the level of equipment with energy-saving devices, the presence in the household of energy receivers with the class "A +++".

The factorial approach will allow finding more viable models for the development of energy conservation in household.

4. Conclusion

However, the state should take certain measures to form the optimal energy-saving behavior of households, taking into account their possibilities of using nature-like technologies. Without the purposeful work of state bodies to create institutional conditions, the effectiveness of the decisions made will be questionable. A number of states have such examples. For example, in France, the cost of purchasing energy efficient equipment is deducted from the tax base of citizens. Lower tariffs apply for more efficient equipment in homes. The United States provides government subsidies ranging from $ 50 to $ 200 for the purchase of new, more efficient home appliances. The Chinese government has also taken a number of measures to curb the growth of energy consumption in households, such as energy efficiency labels, discounts on energy efficient appliances, and the introduction of tiered tariffs. [12].

At the same time, it is necessary to pay attention to the results of the economic calculation of using the advantages of using nature-like technology. It is necessary to take into account the cost of all types of energy [13]. Household income is maximized only with an economical attitude to all types of energy, including electrical, thermal, mechanical, human, etc. For example, when preparing food, a large amount of heat energy is accumulated in the kitchen. In fact, they can be accumulated for later use for other purposes.

The difficulties in calculating energy efficiency were noted in a number of works by scientists [14], [15]. The imperfection of methods for calculating energy efficiency indicators should be noted. Since the principle of economic theory "with other explicit conditions" is often applied, that is, not all quantitative indicators of the consumption of all types of energy are taken into the settlement operation. This also includes the problems of accounting for all types of energy in accounting.

The very formation and development of a nature-like economy will depend on a change in the thinking style of household members in the field of energy conservation, which takes a long time horizon. At the same time, it is necessary to segment energy consumers, that is, a part of the population that has minimal restrictions on the purchase and use of the latest technologies based on economical energy consumption will adapt to new conditions faster than other parts. For example, a small part of the population owns smart home technologies. And among low-income strata of the population, the transformation of energy-saving behavior will take quite a long time, and then with the help of state and public structures.
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