ENERGY ESTIMATION OF EFFICIENCY OF FUNCTIONING OF AGROECOSYSTEM

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Abstract. Monetary methods of estimation do not permit to estimate adequately all functional features of system condition, especially, when it concerns estimations of environment objects and their contribution to the basic processes of system. The energy measure of value is the only objective qualitative measure among those existent, which can provide an actual production value.

In this paper a methodology for energy estimation of functioning of social ecologo-economic system, by the example of agroecosystem, like operationally closed self-organizing structure is put forward.

The prospective model of development agroecosystem is given and on concrete example the resulted methodology is tested. Work above improvement of our methodology proceeds, therefore the considered model demands completion and specification of the received data.

Keywords: agroecosystem, self-organizing system, operationally closed system, invariant structure of functional relations.

1. Introduction. Any kind of human activity is the more profitable, the more contribution is made by Nature into the process of production: it concentrates energy and matter, converts them into new forms, allowing for the creation of various geosystems; recovers already used resources of matter and energy, and brings them into the forms capable of maintaining and supporting dynamic equilibrium. But the efficiency of business operation is sized up by such parameters as cost price to market price ratio; profit to cost ratio, profit to land ratio; etc. Such approach enters distortion into actual costs of production. Labor productivity, in comparison with actual one, is overestimated, which leads to paradoxical results – market price of a commodity, despite of increased energy input used for its production, decreases, which supposedly testifies to a high production profitability.

This widely accepted approach is based on classic market-based economic theories, according to which market price of a product is determined by the demand to supply ratio, which indirectly considers the inputs of labor (energy) in the product. Market advantage, thus, belongs to the business, which, at the same market price, enjoys the minimum cost price (production price). Decreasing production prices are based to the large extend on increased productivity of natural resources (which is often taken for granted), or, in other words, on the amount of useful elements concentrated in these resources, which equals the amount of energy contained in resources plus the amount of energy spent during commodity production. Improving life conditions, progressive social-economic development objectively result in a non-linear increase in the energy consumption.

According to many modern economic theories, natural resources do not possess any value, because they do not include labor; value is attached only when these resources are transformed by man and turned into the new forms of matter and energy. K. Marx reasoning (Marx, 1978) about the use and exchange value of products is widely used nowadays. It is accepted that with the development of technology and growth of industrialization rates, the production price of a commodity decreases. The error here lies in the fact that the output production price doesn't take into account the cost of natural resources. For example, actual price of oil, if calculated by the profit it brings, is about $1000 per barrel.

According to classical economic theories, labor is an expedient activity of Man by means of which Man transforms Nature and adapts it to satisfy his needs. It follows from here, that labor includes only that human activity which is directed towards the conquest of nature and withdrawal of raw materials produced by it. However, industrialization, accompanied by the growth of arms and aggravation of environmental problems leading to exhaustion of natural resources, has brought into the stage a new kind of labor, which is directed towards restoration of habitat. Such labor doesn't lead to the growth of profits in the industrial output. Because of this, the cost of production in terms of energy is only growing in the industrial society. Energy consumed by human society for maintaining its activity is constantly increasing, reaching in the developed countries over 270 thous. kcal/day per person (Odum, 1996). In modern agriculture, production growth of 1% is accompanied by energy consumption growth of 1.8-2.7% (Mindrin, 1997) and production of 1 ton of useful product is accompanied by 99 tones of waste.

In the industrial society every thing existing on the Earth acquires value, because air, water and all other products of ecosystems can be used due to man's labor and energy that are spent on cleaning resources, protection against pollution, forest fires and so forth.

Energy required for the development of a socio-economic system (*E)* is formed from the system's own energy, including the energy produced by man (*Em*), and the energy (*En*) produced by nature:

$$E=Em+En$$

In pre-industrial time and in the beginning of industrial society, the energy *Em* acted, by S.Podolinsky's (Podolinsky, 1991) expression, as a catalyst, "amplifier of the Earth power", which amplified the input of *En* in the production of total energy *E* and additional product. When civilization became industrialized, the input of *En* began to noticeably decrease.

Based on the ideas discussed above, rational and effective use of natural resources and labor consumption can only be assessed and measured using an objective measure – an amount of energy consumed for the production of different types of commodities. This is the only measure of economic effectiveness that allows us to determine not imaginary but actual profitability of any economic activity.

2. Modern Approach to the Problem. The problem of determining the cost of natural recourses in terms of energy accumulated in them attracted scientific attention yet long ago. Some modern ecologists and economists follow the school of physiocrats, the founder of which was Francois Quesnay (Rubin, 1926), who considered the Earth (natural resources) as an unequivocal source of every kind of wealth. Their main idea was that the primary source of added value lies in physical productivity of the Earth.

Scientific substantiation of a thesis, that the energy spent for the production of agriculture product is less than the energy contained in the received yield, was initially offered by S. Podolinsky (Podolinsky, 1991). His ideas were actively supported by F. Engels.

Later on, basic principles of analysis of energy flows in ecosystems, agroecosystems and industrial systems were developed by Howard T. Odum (Odum, 1996). His works, devoted to the measuring global processes occurring in Nature in terms of energy, are based on the energy theory of value and the concept of "emergy", which he introduced. Emergy, according to Odum, is energy used for the production of a good or service, a measure of useful energy accumulated in natural resources, for example, in wood during photosynthesis.

During the last decades this problem was also studied by Russian scientists, as well. A group of scientists from the Institute of Geography of the Russian Academy of Science performed some researches based on the Odum's theory (Feldman, Denisenko, Logofet, 1998; Denisenko, 1990). In particular, using the Odum's factors of transformation, they were first in Russia to estimate the efficiency of agroecosystems located in the Central Chernozem region of Russia.

Russian scientists continued study of the problem: new studies were connected with the assessment of agroecosystems cultivation technologies from the point of view of energy (Bulatkin, 2005), efficiency of agricultural ecologo-economic systems (Chogut, 2007), and methods used to determine such efficiency (Mindrin, 1997). In his studies, A. Mindrin calculated energy equivalents of energy sources (mineral fuels) and characterized in terms of energy the efficiency of agricultural production.

In Mindrin's opinion, the methods of energy analysis used in our country are based on already calculated energy equivalents borrowed from foreign sources (Odum, 1996; Pimentel and others, 1994), which are unacceptable for assessing Russian agriculture, due of obvious differences in production technologies, incomparable natural and climatic conditions, social relations, etc.

The problems of assessing the efficiency of socio-economic systems in terms of energy must be considered in relation with ecological systems. This approach has not been sufficiently developed yet, though the solution of this urgent problem is of paramount practical importance. We believe that difficulties connected with this problem are mainly caused by political reasons, and they are overcomable.

3. General Principles of Analysis of Self-organizing Structures. Any interactions of different elements existing on the Earth, as well as in Nature in general, are accompanied by the processes of structuring and ordering, with the formation of a number of relatively independent stable integrities; the main purpose of their development being to maintain the correspondence of their internal conditions to the external conditions created by non-additive (emergent) set of laws of matter evolution. Availability of ordered flows of energy, matter and information is the necessary condition for self-organization of integrities and their sustainable development. Due to these flows, spontaneous organization of different natural processes on the Earth, including human activity of all kinds, is expedient, has a certain goal. This expedience is shown in the formation of complete sustainable heterogeneous structures developing on the principles of reversibility, which we call *fractal reversibility.* Fractal reversible systems are developing as if contrary to the second law of thermodynamics, they continue themselves in time and space, being replaced with similar structures, often being their invariants. Vivid examples of this rule can be different agricultural communities, cooperative societies, collective farms and so on, which change their structure only to the extend that external conditions have changed, for example, ecological capacity or military-political situation in the region.

The main reason of collisions between Man and Nature is the discrepancy of their goals of development, which in no way can be considered fatal Collisions exist and are becoming more aggravated, because Man acts as if he has the right, ostensibly given to him from Heavens, to rule Nature in order to satisfy his own needs. However, Man's ruling prerogative is strictly determined by the entire logic of cause-effect relations determined by the dialectic laws of matter evolution. The Man's right to rule when interacting with natural processes assumes directed movement to the mutual general purpose – sustainable, harmonious development. The principle – while working on ourselves, we work on others – should be extended onto Nature, because Nature's contribution to the satisfaction of our needs is greater than our own.

Currently conducted studies of energy efficiency of production, in particular of agroecosystems (AES), are directed on studying the energy flows between the elements of AES, energy consumption for the production of different kinds of products; whereas another part of the problem, which is actually more important both practically and theoretically, i.e. study of the system formation mechanisms, the dynamics of energy, matter and information accumulated in the system (expressed, for example, in the form of gross national product or gross output of an enterprise), remains outside the focus of studies. Agroecosystems, as well as other kinds of businesses, are systems with a positive feedback cycle, and their functioning is considered progressive only in case their target output characteristics are growing with time. And this, again according to the principles of positive feedback cycle, objectively assumes the growing environment degradation: the intensity of degradation processes at a given moment of time increases proportionally to the level reached in the previous cycle. In these conditions, most prospective, in our opinion, is to manage agroecosystems as closed self-organizing structures functioning by the principles of operational completeness and autoregulation (autocatalysis, according to Odum, 1996). Such management system should be oriented towards the agroecosystem development, which is based, on the one hand, on unchanging or slowly decreasing external (alternative) energy sources, and on the other hand – on the energy developed by most AES during the closed cycles of production.

4. Methodology of Scientific Analysis for Self-organizing Systems. Further is described the methodology of scientific analysis of self-organizing systems, based on the example of an agricultural farm; described are the characteristics of AES organized by traditional planning and market principles with spontaneously formed *attractive goal,* also described is the model of self-organizing AES as *operationally-closed structure* that can be used in practice these days and further on. The object of study and the set problem require interdisciplinary studies based on the principles and methods of synergetic. Below are described the concepts, definitions and terminology used in the study. These are such concepts introduced by us (Pozdnyakov, 1998, 2007), as invariant structure of functional relations (ISFR), operationally-closed systems, self-regulation by the target state, and attractive goals of development. Other concepts used in the article will be explained hereinafter.

4.1. Invariant structure of functional relations within geosystems (ISFR). The invariant structure of functional relations includes the minimum set of elements required for the system formation: society, its infrastructure and environmental conditions of the territory, which is characterized by ecological capacity *(V)* and area *(Spr)*. Self-organizing systems cannot be formed without ISFR. The absence of just one of the ISFR components results in the system losing its stability, ability to self-restoration and self-reproduction, and further, in the system collapse.

In agrosystems, ISFR acts as non-additive (emergent) amalgamation of the elements included into the ecosystem, socio-economic system, and infrastructure. Each of the components of AES invariant is a relatively independent (autonomous) subsystem, which is connected with other components by functional relations. This system is hierarchically structured into the managing subsystem and the production groups, according to their economic activities.

4.2. Operationally closed self-organizing system. The world consists of self-organizing systems: astrosystems of different ranks, planetary formations similar to the Solar system, the Earth as an independent geosystem, different types of ecosystems and their subsystems; civilizations as a whole and its components – countries, industrial enterprises, agroecosystems and so on. All of them are closed and possess an important property – they keep their self-organized integrity and stability through time, contrary to the second law of thermodynamics. Continuous exchange of energy with the outer environment (or with the other systems) allows geosystems to maintain their parameters and entropy as constants. At the initial stages of the system formation and functioning, the system entropy not only stays at the same level, but even decreases.

Cybernetics – the science of managing dynamic systems – distinguishes two classes of closed systems: negative feedback systems and positive feedback systems. Positive feedback increases the influence of the input parameters on the system output characteristics, and the system quickly grows in size: by mass, volume, area. Positive feedback systems are unstable; their development is fluctuating – fast development is replaced by even more sharply expressed recession.

Negative feedback inhibits the system development, slows down and dampens the growth of output characteristics. Operational closeness of self-organizing systems with negative feedback assumes their purposeful development towards a certain spontaneously formed *target state,* which plays the role *of attractor.*

4.3. Attractive goal, attractor. Attractive goals of development are formed due to the action of two forces: on the one hand, self-organizing systems have the immanent property to conform to the conditions of environment, that is, with the forms of matter, energy and information, due to which they have been formed and developed. Their properties are immanent from the very beginning, because substances possess mass, energy and information *(MEI)*, which are related according to the laws of general interaction. On the other hand, the outer conditions are changing in time and space – environment, forms of *MEI* and their quantitative and qualitative characteristics. Following this changes, the systems evolve, as they literally trace the changing conditions. Thus, attractive goals are the forms of *MEI* due to which systems are being formed and developed. Attractive goals are the main, determining target states for any types of systems, including inert, living, and socio-economic systems.

For this reason, inert systems have their own attractive goals of development, contrary to a popular belief that only people, conscious and capable to analytical activity, can set their goals of development. Attractive goal, thus, represents the central order of Heizenberg (Heizenberg, 1989), which is not in our power to change. Mankind moves along a determined way towards a certain goal, which is conceivable a modern level of science.

5. Agroecosystems as Self-organizing Operationally Closed Systems

5.1. Principles of self-organizing agroecosystems. According to our classification (Pozdnyakov, 2002), agroecosystems are referred to self-organizing structures of the type "man-machine". As any device created by Man, they are organized by Man and can function sustainably only if Man participates in the exchange of matter and energy, if he chooses which animals and plants are to be included into the system. Without Man, self-organizing and self-regulating agroecosystems cannot exist. But at the same time, unlike artificial ecosystems (phytocameras, hothouses, greenhouses), they cannot function without participation of Nature. Moreover, the contribution of Nature into AES development exceeds the contribution of energy introduced by Man. Energy efficiency (ratio of energy contained in the output production E_{pr} to the consumed energy E_c) exceeds the contribution of Man in all forms of energy inputs. Direct and indirect inputs of energy, including human labor, act as a catalyst that increases natural efficiency of photosynthesis and productivity of animals and microorganisms. Thus, AES in their essence are social ecologo-economic systems.

Distinctive feature of AES, like of other types of socio-economic systems, is that management processes limiting the growth of productivity are absent in them. Input governing parameters are mostly directed towards increasing the output parameters (positive feedback). If this does not happen, the enterprise is considered to work unsatisfactory. As an example, let’s take an agricultural enterprise – animal breeding farm “SoMer-2”.

5.2. AES “SoMer-2” – environmental conditions and directions of economic activity. The farm “SoMer-2” specializes in reproduction and culture of breeding animals. Accompanying production includes sausages and dairy products. The farm facilities are located in the steppes of Karaganda region (Kazakstan), where climate is sharply continental and dry – annual amount deposits is less than 350 mm. The grounds are presented by low-power chernozems, vegetative cover – by steppe miscellaneous herbs.

Total occupied area is 10 hectares of agriculture lands, of them 2 hectares are under infrastructure and administrative constructions.

5.3. The farm structure. The farm "SoMer-2” consists of 7 production subdivisions.

1. A pig-breeding farm that is breeding pigs of large white breed. The farm personnel takes care of breeding sows and grows pigs for sale. Accompanying activity is growing pigs for meat.

2. A cattle breeding farm for the stall growing of cattle youngsters of large horned black-motley breed, which is then delivered to the market. Accompanying production – milk and beef, also organic fertilizers in small volumes (manure).

3. A processing shop for animal products – processes pork and beef meat, milk. Here butter and cream in small quantities are sold. Pork and beef are processed into sausages and smoked meat products and are sold via sales network. The products are stored in a large refrigerator.

4. Machine and tractor station and repair shops perform maintenance and repairs of agricultural machinery, automobile transport.

5. Forage preparation and processing shop. Forage preparation is done on natural meadows and fields sowed by grassy and grain cultures (wheat and barley).

6. Food shops selling meat and dairy products.

7. Administration headed by the director, who is the founder of the company, performs management of the entire process. Employees structure: over 50 people of permanent employed personnel and about 20 temporarily employed workers during a harvest season.

Production management and production processes are traditional. Operating instructions are transferred along the divisions hierarchy, where they are implemented in practice and the results are reported back to management. The work results are estimated under the director's lead, also he determines the price policy, which depends on supply and demand in the market.

The company production is in demand, and the cost/profit ratio shows that the company is profitable. The cost of production is about 17750 thous. rubles (658 000 $) per year, and the profit is about 23140 thous. rubles (860 000 $) per year.

There are both favorable and restraining factors in the company development.

Among favorable factors for the company development are low price of electric power, manpower and usage of out-of-date agricultural machinery. The last one advantage seems strange at the first sight. But actually it is connected with the high price for the new equipment. Money expenses required to buy new equipment are considerably higher than those required for the repairs of moral and physically outdated equipment. Modern tractor or combined harvester cost more that annual income of the company. It is more economically to buy old equipment and use it as spare parts in the process of maintaining the existing equipment in working condition.

The restraining factor for the development of AES "SoMer-2" is ecological capacity of the territory, in particular, the area of land. This parameter acts as negative feedback, not allowing the company to develop extensively. Acquiring of additional lands is also difficult for the company, in conditions of growing land prices.

5.4. Types of energy inputs used in the production of AES "SoMer-2". The energy analysis of companies, combined with economic analysis, not only expands cost-price indexes, but also reveals the essence of socio-economic processes in the company more objectively, along with the true inputs of labor in the process of production. All kinds of agricultural and industrial production are the result of a joint and, in essence, inseparable activities of Man and Nature. The energy analysis of production efficiency of different types of agricultural companies allows to compare the companies functioning in different environmental conditions and to compare them with industrial companies.

Accepted approach to energy sources used in the development of ecosystems and economic activities distinguishes solar energy as a separate type of energy, compared by rank with energy of Man and potential energy accumulated by plants and ground (Odum, 1996). Such approach infringes the principles of classification, mixing the main basic source of energy with those whose origin is predetermined and limited by it. The origin of all kinds of energy on the Earth, required for the formation and development of eco- and sociosystems, is caused by solar energy which is being transformed into new forms.

5.4.1. Energy input of Nature The territory of AES "SoMer-2" of 10 hectares accepts solar energy in the amount of 523350 GJ/year or 12 500 tones of oil equivalent (1 tone of oil equivalent =10 Gcal). Solar energy is transformed into energy accumulated by vegetation, ground, etc.

The amount of energy accumulated by vegetation depends on the area of land sowed by grain crops and grasses. 1 hectare of land sowed by grain crops accumulates 21GJ of energy in the average (Mindrin, 1997), and the total accumulated energy makes up 168 GJ/per year.

The soil covering accumulates 296 GJ/year due to the activity of microorganisms and humus formation.

The energy saved due to deposits in the form of rain and snow makes up 173 GJ/ha/year (Odum, 1996), or 1387 GJ/year for the entire area (this energy would be spent on watering, if there were no deposits).

5.4.2. Energy input of Man. Agricultural production uses not only direct, but also indirect energy inputs, that have been used earlier in the production of different equipment - tractors, combines, fertilizers and so on. To determine such energy input, we must consider the total energy consumption, starting from extraction and transportation of ore, steel melting and manufacturing of equipment. With this purpose the methods of quantitative estimation of energy inputs are developed, which consider not only end production, but also the energy spent at each stage of production processes, allowing to determine *energy equivalents* of all resources participating in the production of equipment. This figure must account for total energy input (direct and indirect): at each subsequent stage, to the amount of energy spent at the previous stages, is added the amount energy spent for the new product (Mindrin, 1997, pp. 82-83).

In production process was utilized 61230 GJ/year. Maintenance of major production assets (agricultural machinery, premises) and equipment amortization requires 5100 GJ/year. Considering the above named amortization expenses, total energy inputs will make 66330 GJ/year.

Total energy output in cattle breeding makes up (according to the data of year 2003) 4955 GJ/year; of them: 1165 GJ – due to pork, 110 GJ – beef, 230 GJ – dairy products. Sausage products account for 3450 GJ/year.

6. Prospective Model of AES

Existing production methods in agricultural companies assume exhausting agriculture; the structure of modern AES doesn't include any control elements, which, upon the system's achieving some theoretically and practically proved level of efficiency, would dampen further growth of the system productivity. Upon achieving this level (threshold value), an agricultural company must mainly employ intensive methods of agriculture, which assume joint work with ecosystems, directed to the growth of their efficiency and stability. The company activity should act as an anti-entropy activity in relation to the ecosystem where the company is located and on whose energy the company production depends. The structural diagram of AES management scheme is shown in the figure.

6.1. Negative feedback mechanism in AES structure. Introduction into AES structure of a new control element assumes the change in its target functions, basic change of the attractive goal in the system development. If at traditional variants of organizational structure, the goal is completely determined by the system's own interests and the market, the new mechanism of management requires considering the supply-demand relations within ecosystems themselves, though it might seem paradoxical at the first sight.

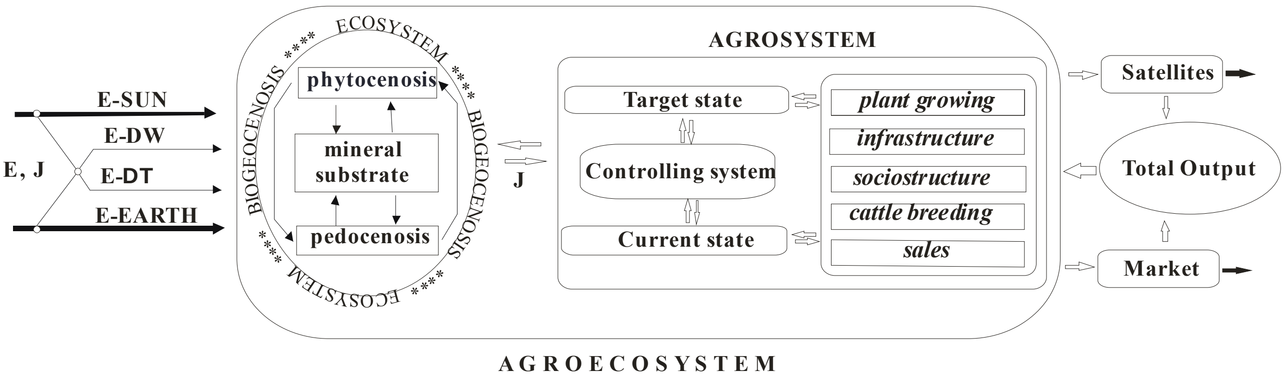

Figure. The structure of functioning of agroecosystem

"Demand" in ecosystems means that the system's invariant shall not be destructed. In other words, changing of *MEI* inputs in the flows between sociosystems and ecosystems should assume the decrease of their joint entropy, aiming to achieve a sustainable condition – harmonious development. But is this possible? If the reasoning is based on political predilections widely used nowadays and the principles of social and economic relations determined by them, this is impossible, because this at first sight simple solution requires that the energy spent on the production of arms should be spent on the stability of ecosystems, and not in a separately taken area, but rather on a global scale. In AES of new type the role of a negative feedback is carried out two structural elements: the target state and ecological capacity. Controlling system AES is obliged (under corresponding state law) quantitatively to estimate limiting volume of made production in concrete territory which excess conducts to degradation of ecosystem, and nature protection supervising systems of the government enact penalty provision (tax obligations AES essentially increase).

In figure the prospective model leaning on principles of functioning agroecosystem as operationally-closed structures with controlling system at the head is presented. Its duties include the production control of system by comparison of the target and current condition agroecosystem in energy and monetary equivalents, the prediction of development of production processes, and the deciding operating instructions.

6.2. Target state of AES. Target (set, planned) state of AES is determined as a level of output parameters which the system should reach after some set time interval: by the quantity and quality of output production, the structure of functional relations, the forms and amount of consumed *MEI.* As a target state, we can take, for example, the number of people busy in the production, material and social conditions of people, etc. However, socio-economic systems, unlike all other types of systems, determine their target state themselves. Transition to the new principles in the organization of production assumes cardinal change in the target characteristics of AES. First, the AES system status is raised – from the category of economic systems it goes into the category of ecologo-economic systems. Second, its output parameters undergo a qualitative change: in addition to the production profitability indicators, there are introduced additional indicators of sustainability and efficiency of ecosystems, with consideration for biological variety. The goal is to achieve harmonious interpenetration of the systems, which assumes simultaneous and interconnected improvement of their condition. The part of ecosystem, included into the existing AES, must be considered according to the “demand-supply-price” principle. The production cost here must be determined both in energy and money terms. The ecosystem’s supply includes ground fertility, cleanliness (pollution level) of water pools and underground water sources, bioefficiency of forest and park areas, etc.

Control structures in ecosystems (biocommunities) are presented by genotypes (set of hereditary factors) of plants and animals and environmental conditions (temperature mode, humidity, insolation and mineral substratum), under which the existing genotypes and phenotypes were formed by evolution. Ecosystems can be controlled according to several most important output characteristics: productivity and sustainability, biodiversity.

Productivity $P(t)$ of ecosystems, due to inhibiting action of negative feedback, upon having achieved some optimum state P_o, is stabilized - $\Delta P(t)\rightarrow 0$. Thus, P_o in ecosystems acts as spontaneously formed target state, and parameter $p(t)$, approaching P_o ($p(t)\rightarrow P_o$), – as a current state, where $P(t) = P_o - p(t)$. In the simplest variant of AES management, the controlling body must perform the comparison of the current state $p(t)$ with the target state P_o. At this point quantitative characteristic of target state is defined by capacity ecosystem: limiting quantity of made production and pollutants at which in phytosenosis surrounding area of AES, in souls and water ground mode, surface water and firm drain, do not occur irreversible changes. The given parameter, except for economic gain, represents itself as knowingly formed attractive goal of AES which is constantly compared to current state of ecosystem and the enterprise (figure).

At this, when limiting conditions are set, saturation is proportional to the difference between the target and the current states, and when the limiting conditions of the system are formed spontaneously, the process is proportional to the difference between the total supply and the total demand. Because supply due to exhausting resources (at short time intervals – due to the stabilizing role of price) fades, the process, in the result of total interaction "demand-supply", aspires to balance. Socio-economic system thus is characterized by stationary, dynamically equilibrium mode of development: its output parameters vary little with time.

Socio-economic systems use as a target state their own output characteristics, connected by different types of feedback (negative and positive) with their controlling bodies. When necessary, these target characteristics damp further growth of production, or, on the contrary, stimulate labor productivity.

The target state should be set for each specific goal and should be achievable in concrete conditions.

The effect of negative feedback, adjusting the company dynamics, for example, by the volume of production, is seen through the relation of *target and current state* of socio-economic system: productivity of socio-economic system, in the process of approaching the current state to the target state, is stabilized.

7. Conclusions. The energy analysis in comparison with economic gives more objective picture of condition of system or process from a position of nature because cost estimations, as against energy, can appear incorrect at comparison of efficiency on the countries and during time since depend on a conjuncture of the prices for raw material, energy carriers, agricultural production and inflationary processes. The contribution of nature is taken into account, that’s why full expenses of energy are defined and what is more mankind can prevent degradation of environment by means of filling of energy consumption.

It is natural, that the valid production efficiency from positions of applied methodology is defined by the energy contribution ecosystems - the efficiency of production grows with increase in its share. The given circumstance, generally speaking, is perspective strategic reference point in the further development of mankind. In production, first of all agricultural, it is necessary to prefer the decision of those problems which assume increase of the power contribution of the nature: to increase in potential efficiency souls, to reception of energy in the closed cycle of manufacture, to use of the production wastes which have been preliminary last processing, for example, by means of microbiological technologies, increase of efficiency of use of a solar energy (increase in density of energy) and so forth.

The most perspective is transition to management agroecosystem as complete self-organizing structure functioning on principles of operational isolation.

References

- Bulatkin, G.A (2007) Ecologo-energetical aspects of reproduction of fertility soils and increase of efficiency agroecosystem, *Abstract of dissertation on competition of a degree of Doctor of Science*, Moscow, 45 pp.

- Chogut, G. I. (2007) The efficiency of functioning of ecologo-economic systems in agriculture: the theory, methodology, practice, *Abstract of dissertation on competition of a degree of Doctor of Science*, Voronezh, 45pp.

- Denisenko, E. (1990) *Mechanisms of functioning and structural organization of agroecosystems*, Moscow, Institute of Geography of AS of Russia, candidate dissertation, 160 pp.

- Feldman, O.V., Denisenko, E.A. and Logofet, D.O. (1998) The emergy assessment of efficiency of use of nature resources, *Problems of environment and natural resources*, VINITI, Moscow, pp. 66-81.

- Heizenberg, V. (1989) *Physics and philosophy. The part and the whole*, Science, Moscow, 400 pp.

- Marx, K. (1978) *The capital*, Politizdat, Moscow, V. 1, 908 pp.

- Mindrin, A.S. (1997) *Energy-economic estimation of agricultural production*, CSSIM, Moscow, 294 pp.

- Odum, Howard T. (1996) *Environmental accounting: EMERGY and environmental decision making*, Howard T. Odum, N.-Y., 370 pp.

- Pimentel, D., Rodrigues, G. and Wane, T. (1994) Renewable energy: economic and environmental issues, *BioScience*, Vol. 44, № 8.

- Podolinsky, S. (1991) *Man's labour and his relation to distribution of energy*, Noosphere, Moscow, 89 pp.

- Pozdnyakov, A.V. (1998) *The strategy of the Russian reforms*, Tomsk: Print IOA the Siberian Branch of the AS of Russia, 272 pp.

- Pozdnyakov, A.V. (2002) Problem of globalization and steady development, *Problems of sustainable development: illusions, reality, forecast*, *Proceeding of Sixth All-Russia Permanently Functioning Scientific Seminar on Self-organization of Holistic Structures in Nature and Society,* Tomsk state university, Tomsk, pp. 229-235.

- Pozdnyakov, A.V.(2007) The system synergetic approach to research of geosystems, *The surface, tier relief and rate of bulge forming: Materials of the Irkutsk geomorphological seminar, Readings of memory of N.A.Florensova (Irkutsk, September, 9-14, 2007)*, Irkutsk, Institute of earth's crust of the Siberian Branch of AS of Russia, pp. 223-225.

- Rubin, I. I. (1926) *The Physiocrats*, Moscow, pp.84-85.