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Synergetic approach as the basis for efficient development of the fuel and energy complex

Igor P. Zasuha

Deputy Director of Commercial Public Joint-Stock Company "Centrenergo", Kiev, Ukraine

Email address:
i-zasuha@mail.ru

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Abstract: The work is devoted to the study of processes to optimize the system of government of the fuel and energy complex in the face of strong action of factors of socio-economic self-organization. One of the most effective approaches to common problems of description complexity, self-organization characteristics of the phenomena considered synergetic, formed as an interdisciplinary scientific approach, which develops methods for studying the behavior of open systems and complex behavior of their components. The objective of the study is to develop concepts and models to optimize the system of government fuel and energy komples, effective under conditions of intense socio-political and socio-economic self-organization of the social environment of the country. It is proved that the concept of synergy gives new impetus to the theory of public administration, combines elements of the power controls and self-control object.

Keywords: Synergetics, Fuel and Energy Complex, Governance, Environment, Energy Crisis, Public Policy, State Programs

1. Introduction

This article will focus on the philosophical concept of "Synergetics" in the light of the prospects for energy sector development and solving the issues for environment quality improvement.

The age we are living is marked by the rapid development of the natural sciences. The major objective of this article is to disclose the concept of synergetics as a new promising direction of philosophy, which at present stage allows us to expand the variety of searches and approaches in various fields of social, scientific and cultural development. Currently we are facing the continuous development of diversity, evolution to the emergence of more complex forms of the matter development.

Being relatively new, this field of research covers a very wide range of problems. These problems are related to the theory of bifurcation which examines the emergence of new solutions of differential equations at critical points or bifurcation points; it is shown in which cases it is advisable to apply the concepts of dissipative structures and order through fluctuations; what are the types of coherent behavior and how they are related to the relevant molecular mechanisms and external impacts on the system [1].

Against the background of the analysis and the problems of use of the major energy resources of the Earth - oil, gas, coal, nuclear and hydro power, the article focuses on the issues of energy shortfall and energy consumption in the world and in Ukraine, the prospects for the use of alternative energy sources - solar energy, wind and ocean energy, Earth's internal heat, bioenergy, unconventional sources of liquid fuel and gas.

Currently, the ideology of "economics" is ruling in the world, mounting the economical principle on a pedestal of wisdom and presuming any deviation from the free market as a "path to slavery". But the nature is powerfully intrudes upon the "history of people" and from its fund it becomes an active copartner of the historical process. Moreover, it is like a severe judge threatens with punishments to all those who unquestionably accept the squalor of the modern Western idea [2].

The synergetics is the science about development of the complex systems. The term synergetics was firstly used in the scientific researches in XIX century by the British physiologist Sherrington in the analysis of muscle systems' control by the spinal cord side.

The second scientific "birth" and the following triumph of the term synergetics falls on 70-ies of XX century when the German physicist Hermann Haken started to call a new scientific discipline as synergetics. Thus H. Haken characterized the synergetics as follows: "I called a new discipline as "synergetics". It explores the combined action of many subsystems which results in the emergence of the structure and appropriate functioning on the macroscopic

level" [3,4].

Later, at Berlin symposium on synergetics in 1984, H. Haken explained the following in layman's terms about synergetics: "Synergetics can be regarded as forum where scientists from different disciplines meet each other in order to share their ideas how to cope with large systems" [5].

According to the current classification, the synergetics refers to the category of philosophic sciences.

2.Research Findings

The synergetics is the scientific discipline which deals with the system integration process regularity and self-organization in different systems. In contrast to the systematic approach, where the main emphasis is pointed on the ties of the parts in general, the synergetics investigates the reasons of the system properties. In the system approach the analysis is conducted generally on qualitative level. The synergetics is studying the quantitative relations and parameters[6].

The synergetics is researching the systems consisting of large (very large, huge) number of parts, components or subsystems, in other words, the parts interacting in a complicated manner.

The synergetics is not the only scientific field that deals with the study of complex systems. In the meantime, those concepts used in the synergetics make the synergetic approach as unique, not only conceptually, but also operationally. In contrast to the other scientific fields, usually appeared at the junction of two sciences, when one science provided the subject to a new direction and another science provided a research method, the synergetics is based on mathematical models similarity, ignoring the different nature of the systems they are depicting [7].

One of the synergetics sections is the physics of automated media and their ongoing auto-wave processes. These processes occur in any open systems (biological, physical, social, etc.), i.e. the systems far from thermodynamic equilibrium in which the flow of energy is carried out from the outside. The media in which they arise are called active or excitable in contrast to non-excitable (passive) media. An active medium can be represented as a network formed by the individual active elements. Each element of the active medium may reside in one of three states: rest, relaxation and excitation. All elements of the active medium are related with one property - transfer of the wave processes that run through the medium. The transfer is carried out through the "swap" of energy from the outside to the medium element[8].

The synergetics (S.) (from the Greek word synergia – cooperation, contribution, co-participation) an interdisciplinary direction of scientific research in which the general processes regularities of transition from chaos to order and back are studied (self-organizing processes and spontaneous disorganization) in the open nonlinear systems of physical, chemical, biological, environmental, social and other nature. S. as a scientific direction is close to a number of other directions, such as nonlinear dynamics, theory of complex adaptive systems, theory of dissipative structures (I. Prigogine)[19], theory of deterministic chaos or fractal geometry (B. Mandelbrot)[9], theory of autopoiesis (H. Maturana and F. Varela), theory of self-organized criticality (P. Bak)[10], theory of unsteady structures in blow-up regimes (A. A. Samarski, S. P. Kurdyumov) [11,12].

The essence of S. approach is that the complex systems consisting of a large number of elements, having complicated interactions with each other and possessing a huge number of degrees of freedom can be described with a small number of essential types of motion (order parameters), and all other types of motion are "subordinates" (principle of subordination) and can be rather accurately expressed in terms of the order parameters. Hence the complex behavior of the systems can be described with hierarchy of simplified models including a small number of the most essential degrees of freedom. The synergetics is an area that is rather far from being complete and we do there only the first steps [13,14].

It is known that the thermodynamics covers the systems that are in thermal equilibrium, whereas the synergetics studies the systems far from the thermal equilibrium. But here there is a rather peculiar situation. On the one hand, we can always insert an open system into closed system enveloping the first one. For example, the Earth represents an open system as it receives solar energy and while cooling at night it gives energy to the outer space. But taking the Sun and, let's say, a part of the Universe as a whole system, we can consider this system as a closed one, which can be subjected to the laws of thermodynamics. On the other hand, any open system can be considered at the limit, when the energy or substances flows tend to zero and we will eventually have to deal with a closed system. Consequently, the general laws of thermodynamics should be obtained as limiting cases of the general laws of the synergetics. The closed system can be considered as a limiting case of an open system, which has prevented flows of energy at input and output [15].

The processes ongoing in closed, isolated and close to equilibrium systems, according to the second law of thermodynamics, tend to thermal chaos, i.e. to the state with maximum entropy. In open systems far from the states of thermodynamic equilibrium, there may appear ordered spatiotemporal structures, i.e. there are ongoing processes of self-organization. The structures-attractors show where the processes evolve in open and nonlinear systems. Every complex system usually has a certain set of possible forms of organization, discrete spectrum of structures-attractors of evolution. The critical moment of instability, when a complex system selects the future path of evolution, is called a bifurcation point[16].

The moments of qualitative change in the original system are calledbifurcations of the state and are described by the relevant branches of mathematics - catastrophe theory, nonlinear differential equations, etc. The scope of systems subjected to such kind of phenomena appeared so wide that allowed to talk about the catastrophes and bifurcations as the universal properties of matter [17].

The motion of matter in general can be considered as an alternation of the stages of adaptive development and the

stages of catastrophe behavior. The adaptive development involves changing the parameters of the system, while maintaining the constant order of its organization. Under change of external conditions the parametric adaptation allows the system to adapt to the new constraints imposed by the medium.

The catastrophe stages are the transformations of the structure of the original system, its rebirth, emergence of a new quality. It turns out that the new structure allows the system to switch to a new thermodynamic pathway of development, which has a lower rate of entropy production or a lower rate of energy dissipation [18].

The emergence of a new quality occurs on the basis of amplification of small random movements of elements - fluctuations. This explains in particular the fact that at the bifurcation point of the system state there may be not one but plurality of variants of structural transformation and further development of the subject. Thus, the nature itself limits our ability to accurately predict the development, leaving, however, the possibility of important qualitative conclusions.

That is, the synergetics is entirely in line with the traditional dialectics, its laws of development - transition from quantitative to qualitative changes, negation of the negation.

Close to this bifurcation point there appears a dramatic increase of the role of minor random perturbations or fluctuations, which may lead to the emergence of new macroscopic structure.

What are the fluctuations? Any objects around us are the systems, i.e., the totality of their constituent elements and relations between them.

The elements in any system, in turn, always have a certain autonomy behavior. While formulating any scientific problem there are always certain assumptions that push outside consideration some non-essential parameters of the individual elements. However, this micro-level of the system elements independence is always present. Since the motions of the elements at this level are usually not of interest to the researchers, they are generally referred to as "fluctuations." In our everyday life, we also focus on significant, informative events, ignoring the least, subtle and minor processes [20].

The low level of individual display of certain elements suggests the existence of some mechanisms of collective interaction within the system - feedbacks. When collective, systemic interaction of elements leads to the fact that certain motions of the components are suppressed, we should speak of a negative feedback. Strictly speaking, namely these negative feedbacks create systems as sustainable, conservative, steady assembly of elements. Notably the negative feedbacks thus create the world around us as a sustainable system of sustainable systems.

The stability and sustainability however are not unchangeable. Under certain external conditions the nature of the collective interaction of elements varies drastically. The dominant role is played by the positive feedbacks that do not inhibit but rather strengthen the individual motions of the components. The fluctuations, minor motions, former insignificant processes are forwarded onto the macro-level. This means among other things the emergence of a new structure, new order, new organization in the original system.

It is always possible to introduce the fluctuations that lead to instabilities and new types of structures and functions. In other words, no one system is structurally sustainable with the evolution of dissipative structure determined by the sequence of events in accordance with the following scheme “Fig. 1”.

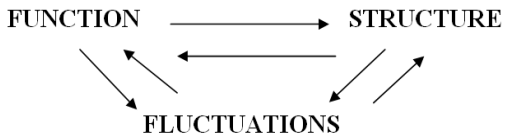

Figure 1. *The evolution of dissipative structure.*

The moment when the original system loses its structural sustainability and qualitatively regenerates is determined by the laws of the system operating with such system values as energy, entropy.

The academician of the Russian Academy of Sciences N.N. Moiseyev said that "...a special role in the global evolutionary process is played by the principle of minimum energy dissipation. It can be formulated as follows: if not the only one state of the system (process) is acceptable but the whole set of states consistent with the conservation laws and ties imposed on the system (process), then that state will be implemented which corresponds to the minimum energy dissipation or equivalently to the minimum increase in entropy".

It is fair to say that the principle of minimum energy dissipation mentioned above by the academician Moiseyev is not recognized as a universal natural science law. Ilya Prigogine, in particular, has pointed the type of systems that do not conform to this principle.

The self-organization structures possessing the property of self-similarity or large-scale invariance are called fractal structures. These structures can be identified in a variety in different areas of life.

Being an interdisciplinary field of research, the synergetics entails a profound worldview implications. A qualitatively different world view distinct from classical science emerges.

The interdisciplinarity of the synergetics consists in the following: the systems subject of the synergetics study can be of very different nature and can be substantially and specifically studied by the various sciences, such as physics, chemistry, biology, mathematics, neurophysiology, economics, sociology, linguistics (the list of sciences could be easily extended). Each of the sciences studies its "own" systems with its own inherent methods and the results are formulated with its "own" language. Considering the current advanced differentiation of sciences, this leads to the fact that the achievements of one science are often inaccessible to the attention and understanding of other sciences.

A new paradigm is formed, the whole conceptual grid of thinking is changed. We observe the transition from the categories of the being to the event, from the existence to the becoming, the coexistence in complex evolving structures of the old and the new; from the ideas about stability and

sustainable development to the ideas about instability and metastability, protected and self-sustaining (sustainable) development; from the images of the order to the images of chaos generating new ordered structures; from the self-sustaining systems to the rapid evolution through the nonlinear positive feedback; from the evolution to the coevolution, coherent evolution of complex systems; from the independence and isolation to the cohesion, the coherence of autonomous; from the dimension to the proportionality, the fractal self-similarity of formations and structures of the world. The new synergetic worldview emphasizes on becoming, co-evolution, coherence, cooperativity of the elements of the world, non-linearity and openness (various options for the future), the increasing complexity of formations and their associations into evolving integrities. Let us try to apply the principles of synergetics to the realities of modern life, as there can be seen a very close relationship between the synergetics and the power engineering which are currently the fundamental components of the development prospects for the whole society.

In particular it is worth to note that currently an urgent problem is the energy security for the life and activity of many states. In July 2006, in St. Petersburg, three-day G-8 summit was held where Russia, USA, Great Britain, France, Japan, Germany, Canada and Italy were deciding how the leading countries of the world will live in the future. One of the main issues of the summit was the power engineering. A joint working group of the experts from Russia and the United States has already begun work on the unification of two initiatives - Russian one about creation of the international enrichment centers and American one about global partnership in the nuclear field. According to the heads of the "Big Eight" states this shall contribute to the fastest transition of the world economy to alternative sources of energy generation, as well as the better control of the safety of nuclear facilities and the non-proliferation of nuclear weapons in the world. Ukraine is seeking to take part in the summit of the "Big Eight", with this purpose the government of Ukraine addressed to the summit participants with proposal to expand the dialogue between the consumers and the suppliers of energy with involvement of the "transit countries". Despite a willingness to negotiate, the role to be played by our country on the future energy market is not yet decided.

The birth of power engineering occurred several million years ago, when people learned to use fire. The fire gave them heat and light, it was a source of inspiration and optimism, a weapon against enemies and wild animals, remedy, assistant in agriculture, preservative of foods, technological means, etc.

Over the years, the fire was maintained by burning plant fuels (wood, shrubs, reeds, grasses, dried seaweed, etc.) and later it was found possible to use fossil materials to keep a fire burning: coal, oil, shale, peat.

The beautiful myth about Prometheus who gave the fire to people appeared in Ancient Greece much later than in many parts of the world the quite sophisticated methods of handling the fire, its starting-up and extinguishing, keeping up the fire and rational use of fuel have been mastered.

The mankind needs energy and the need for it is increasing year by year. However, the stocks of conventional natural fuels (oil, coal, gas, etc..) are finite. The nuclear fuel stocks - uranium and thorium from which you can obtain plutonium in the breeder reactors are also finite. Virtually inexhaustible are the reserves of thermonuclear fuel - hydrogen, however the controlled thermonuclear reactions have not yet developed and it is unknown when they will be used for industrial energy generation in its pure form, i.e. without use in the process of fission reactors. Due to these problems it becomes increasingly necessary to use non-conventional energy sources, primarily solar, wind, geothermal energy along with the introduction of the energy saving technologies.

Among the renewable energy sources the solar radiation is the most promising with regard to the scale of resources, environmental friendliness and global presence.

For the first time the possibility of practical use of a huge solar energy by people was pointed by the founder of theoretical astronautics K.E. Tsiolkovsky in 1912 in the second part of his book: "Investigation of Outer Space Rocket Devices". He wrote: "Rocket devices will win for people unlimited space and will provide solar energy by two billion times greater than that one the humanity has on the Earth".

We have not only the Earth but the whole vast Outer Space, which resources are varied and inexhaustible. The optimists believe - the time will come when all of the most energy-intensive and hazardous industries to humans and other living organisms will be located in the outer space and the Earth, extraordinarily beautiful and well-groomed "cradle of the mind", will be used only for recreation, treatment and some environmentally friendly researches.

In the meantime, we are the eyewitnesses of a very different (if not opposite) picture of the world.

The solar energy can be used both on Earth and in the outer space. The ground-based solar power plants should be built in the areas located as close as possible to the equator with many sunny days. Currently, the solar energy is economically feasible for use for hot water supply of seasonal consumers such as sports and fitness facilities, recreation centers, summer housing estates, as well as for heating outdoor and indoor swimming pools. In hot and dry climate of Central Asia it rational to use the plants for cooling the buildings and structures, agricultural facilities, poultry houses, for storage of perishable food, medicines, etc.

In terms of the synergetics, in the coming years Ukraine may be close to the point of energy bifurcation that requires from the state authorities non-trivial measures to overcome the approaching catastrophe. Let us try to operate with facts.

As it is well known, the main criterion of economic status of any country, its development in the future is the energy resources endowment of the state. The availability of raw materials and in particular energy resources has been and remains a condition of wealth of the state, its political position and defense capacity.

However, the history of energy consumption in tsarist Russia and the former Soviet Union has its own specific character. If the first half of XX century was called "Golden Age" of the coal industry, which has its highest development

in the age of the Soviet Union, then in the second half the oil advanced to the forefront. The end of XX century and the beginning of XXI century, in spite of the dominance of oil, already referred to as the century of the gas (the growth rate of gas consumption is much higher than the growth rate of consumption of other fuel and energy resources (FER). According to long-range forecast period the dominant types of FER may be nuclear, thermonuclear or hydrogen fuel, as well as the new renewable energy sources (NRES). Thus, the technological progress of any country is largely determined by the development of its fuel and energy complex (FEC).

The energy security is understood as the security state of the country (region), its citizens, society, their serving economy against threats to the reliable fuel and energy supply.

Under normal circumstances, such security state corresponds to the provision in full of the demand for fuel and energy resources at economically reasonable prices and under emergency situations (at the bifurcation points) – the guaranteed provision of the minimum vital needs. The energy security of Ukraine is a prerequisite for maintaining the required level of national and economic security through the efficient use of fuel and energy potential of the country. At the present moment it is a beautiful dream.

The energy independence of the state is determined by the level of self-governance of the state in the formulation and implementation of the policy independent of the external and internal interferences and pressure coming out of the FEC scope, which does not exist in today's Ukraine. The problem of achieving the energy independence is one of the most urgent objectives of any state, including Ukraine, and it becomes more pressing as less the state's own fuel and energy resources are available which are used to produce electrical and heat energy.

Currently, Ukraine is largely dependent on foreign energy supplies. The share of import in the supplies of fuel and energy resources to Ukraine (about 50%) is on the average European level, but the monopolistic dependence on oil import (about 70%), gas (71%) and nuclear fuel (100%). At the same time the major difficulties in building-up the volume of domestic production of coal, oil, gas, and unsatisfactory balance of energy consumption (significant share of the use of gas about 45% of total consumption compared to the average European - 22%) exacerbate the problem of energy dependence.

The promising area in Ukraine in terms of exploration and development of hydrocarbon natural resources are the waters of the Black sea and Azov sea, where by 2010 it is planned to develop a total area of 1.6 thousand. sq. m.

The only real source of energy in Ukraine, as well as throughout the world, is a coal. Ukraine owns 3.5% of its world reserves. Given the lack of own oil and gas production the coal can be a reliable source of energy in the fuel and energy balance of Ukraine in the long term range.

However, the continued crisis in the coal industry does not allow to use in full the advantages of solid fuel – the coal. In 1990-2004 the coal production capacity decreased by 126 million tons, and only 17.9 million tons of capacities commissioned. If the immediate actions on development of the coal industry are not taken, in the near future Ukraine will import not only oil and gas, but also coal. All of the above issues approach the country to the bifurcation point and if the problem is not solved but exacerbated - the inevitable political and social restructuring.

One of the significant (almost 50% of electricity production) and promising energy sources in Ukraine is a nuclear power. Thus the needs in uranium for nuclear energy in Ukraine are satisfied by 30% due to the development of Vatutinsky, Central and Michurinsky deposits. After commissioning of Novokonstantinovsky deposit in the future there will be a possibility to reach 100% level of uranium supply. Ukraine is fully secured with zirconium supply.

At the same time it became clear that the environment cannot cope with the environmental load caused by emissions of fossil fuel combustion products. The nuclear energy emits sulfur, carbon, nitrogen, phosphorus compounds and other pollutants by 10-1000 times less than coal. And in this regard it is out of the competition. However, a significant disadvantage of nuclear energy is increased (by the tens of thousands times compared to the average raw material input) radioactivity of the spent nuclear fuel (SNF) and the presence of long-lived isotopes not naturally occurring that requires special restrictions with regard to their isolation from the biosphere. The most intractable problem is the SNF accumulation of high background plutonium, transuranic elements, having a large radioactivity and long half-life. Therefore, to ensure the viability of nuclear energy it is necessary to solve some key problems. One of the biggest problems is associated with the development of strategies for the treatment of spent nuclear fuel and high-activity wastes and their disposal.

The second key issue is the safety of the society and the nature. The creation in the past two decades of the powerfulinternational networks on nuclear safety has already yielded its results that we can note the safety has significantly improved. However, the problems to be solved are still remaining: in some cases the existing plants based on outdated technical solutions require upgrading or additional measures to ensure the necessary level of safety.

It is also important to emphasize that no matter what choice is made in the energy production in a particular country, it is necessary that all countries are involved in the activity to ensure the highest standards of safety at nuclear facilities. The nuclear safety assurance is the common interest and this problem should remain at the level of other global priorities.

The third key issue is the so-called physical nuclear safety. The terrorist attack on the United States in September 2001 led to the reassessment of the level of physical nuclear safety in every industrial sector, including nuclear energy. The scale and the scope of activities to ensure physical nuclear safety both at the national and the international levels have increased.

However, the situation in Ukraine is different – in the vicinity of the existing nuclear power plants there are military bases with thousands of tons of ammunition. It is deadly dangerous neighborhood given the events in 2004 at the artillery base in Novobohdanovka. Thus, 8 km from

Khmelnitska NPP there is Slavuta village and 22 km from the same NPP there is a residential area Tsvetoha, where potentially dangerous depots with missiles are deployed. At the large arms depot in Burski hutora 22 km from the South Ukrainian NPP in Mykolaiv region there are stored 5-ton and even 8-ton bombs. 40 km from Zaporozhska NPP in Novobogatovka there is also a warehouse with missiles.

The ammunition are stacked allegedly reliably, but any damage, mechanical or thermal impact, or the sadly remembered "human factor" can trigger an emergency.

These examples are further confirmation of the conclusion that the principles of synergetics should be explored and the probability of various types of emergencies should evaluated with mathematical precision, and the results are taken into account when providing favorable development of our society.

It should be noted that in 2004 there were 469 power units in operation around world. In total they provided 16% of the world electricity production. This figure has remained relatively stable over the last 20 years that confirms the fact that nuclear power was developed at the same rate as the total electricity consumption.

The electricity production based on nuclear energy is concentrated in the developed countries. More than half of all reactors in the world are located in North America and Western Europe, only 10% are in developing countries, despite of the fact that in the latter countries it is expected to have the most rapid growth in energy demand in this century. The most significant prospects for the spread and growth of nuclear power are found in Asia. Out of 31 units being currently under construction in the world, 18 are located in India, Japan, South Korea and China, including Taiwan. Twenty of 29 latest reactors to be commissioned are also located in the Far East and South Asia.

In Western Europe and North America, the construction of nuclear power facilities had been frozen. In Ukraine in 2004 two units with capacity of million MW at Khmelnitska and Rivne NPPs were commissioned. Now Ukraine has a surplus in electricity production and turned into the state of export of electricity. Ukraine is the third European country with the developed nuclear power engineering.

It should also be noted that the readily available uranium deposits for the development can supply fuel to the nuclear reactors for 50-60 years, and in the future, due to the advanced techniques of uranium release the reactors can operate for thousands of years, as stated in IAEA report dedicated to the 50th anniversary of the commissioning of the world's first nuclear power plant.

The hydropower engineering which has considerably large renewable resource and performs the regulation function with the lowest cost of electricity production, for a long time (since 1985) had little development in Ukraine. The total capacity of hydropower in Ukraine makes 4840 MW.

In recent years, the regional authorities widely support the development of the so-called small-scale generation or non-conventional generation. The wind, the sun's rays, the tidal motions of the sea, bioenergy, etc. are used as the energy resources. Till now the capacity of the small-scale power generation makes 99 MW.

Currently, the solar power plants are being built mainly of two types: tower design SPP and distributed (modular) design SPP.

The analysis of the use of the main fuel and energy resources in some countries of the world show that in case of lack in a certain country of relatively large reserves of fuel and energy resources, it has the ability to use such energy sources such as nuclear or thermonuclear, new renewable energy sources (NRES), hydropower, wind, solar energy etc.

The analysis of the prospects for development and use in Ukraine of the fuel and energy resources (FER), as well as its fuel and energy balance (FEB), shows that despite some positive moves towards the compliance with the global trends and requirements the undeveloped potential is still very significant.

Based on international FEB construction experience with consideration of energy security assurance it can be concluded that the fuel and energy balances of the developed countries pay more attention, compared to that one in Ukraine, to the requirements to ensure energy independence.

Analyzing the global experience in creating the fuel and energy balance, the energy policy in Ukraine in regard to FEB formation should consider the following factors to ensure its own energy independence: achieving the world efficiency of production, transmission and consumption of energy; significant reduction of the share of gas and oil and accordingly increase of the share of coal in FEB of the country, providing the accepted level of diversification of necessary FER import; avoiding the situation with exclusive preferential use of one or another type of FER, the need to find and to introduce a large-scale additional production capacities at HPPs, NPPs, new renewable energy sources and others. The development and implementation of such policy would enable Ukraine to ensure a high level of energy security and energy independence, significant improvement of the competitiveness of the national economy and to take its rightful place among the developed countries of the world.

In conclusion, it should be noted that presently the fuel and energy complex (FEC) of Ukraine is the major part of the national security and economic growth of the state. The economic stability of the country, self-sufficiency and improvement of the living standards of the population depend on the consistent and reliable operation of fuel and energy complex.

It is appropriate to mention here that FEC is one of the most powerful pollutants of the biosphere and its development cannot be considered without taking into account and addressing the environmental problems as one of the factors increasing or not the risk of bifurcation of the Ukrainian social development.

All reasoning and arguments about the possible ways of future development of society and the nature of its development, both in the planetary situation and during the analysis of local perspectives, should be based on idea that the human being is the natural element of the biosphere, that he originated in the result of its evolution and the human, as other

living species, is subject to the laws of development of the biosphere. Like any living species, the mankind has its own ecological niche, i.e. the system of interrelations with the environment which laws the human is required to take into account in his practical activity and derogation from which is fraught with catastrophic consequences for the society.

This statement seems to me as trivial and I perceive it as a starting postulate for all reasoning. However, its consistent use leads us to a number of highly unusual findings, many of which can meet rejection or become the subject of debate. One of the empirical generalizations relating to the development of the living world is as follows: if any species becomes a monopolist in its environmental niche, it will inevitably experience environmental crises aimed at recovery of equilibrium disturbed by the monopolist. For the first time this was demonstrated by Voltaire at the model level. Usually, the result of the environmental crisis provoked by the species-monopolist and always associated with disturbance of the equilibrium within the environmental niche may have one of two outcomes.

The species which due to various reasons has become a monopolist usually quickly exhausts the resources of its environmental niche and suffers distress. In this case, its number is drastically reduced. It is still capable some time and somehow to fit its lifestyle and its biological characteristics to the new conditions, it tends to restore its lost equilibrium with the other elements of the environmental niche, but it is not always possible and most often the development of the species is stopped. This situation means the beginning of degradation of the species. At the same time of course the species loses its monopoly position in the niche. It may even completely disappear. Another outcome is the expansion of the environmental niche and the appropriate change of its lifestyle and its organization (both biological and supraorganismal, i.e. social). With such outcome the development of the species can be continued and the species is able to maintain its monopoly position in the new, expanded environmental niche.

The development of the humanity is also subjected to this law, especially it is as a species has long been doomed to a monopoly. And in the last century the vigorous activity of people is rapidly changing the entire face of the planet. Even at the beginning of the century V.I. Vernadsky said that the man turns into a major geology forming force of the planet. His monopolism became unprecedented.

Therefore, the environmental crises in the history of humanity are inevitable.

And because its oecumene (not niche but namely oecumene) is now the entire planet, these crises must be global in nature and affect the fate of the entire biosphere and not only the fate of the living matter. In other words, the environmental crises of humanity turn into restructuring not only the biosphere but also the entire upper shell of the planet. The crises of humanity turn into epochal events of the Earth's history.

At the present stage of its history, the mankind must learn to anticipate such crises and create new environmental niche, changing its lifestyle, its needs and the nature of the vigorous activity.

The humanity became a monopolist most likely at the dawn of the Paleolithic age, when the throwing weapon was invented and people have mastered the fire. Therefore, during its long history it has survived apparently several environmental crises. And as it continued to evolve, it has been repeatedly changed and expanded its environmental niche. This prehistory of the mankind is little known, but one of the crises we know for certain, because it occurred on the eve of the Holocene, shortly before the written history and marked the beginning of the modern civilization (i.e., about 10-12 thousand years ago). In the literature it is known as the Neolithic crisis and it had practically the planetary nature.

At the beginning of the Neolithic period the people were primarily the hunters (and gatherers). However, with improvement of weapons the mankind rather quickly, maybe even in one or two millennia, exterminated all large ungulates and mammoths - the basis of their diet since the early Neolithic period, and the hunting could no longer provide the food for people. The man was on the verge of starvation and was doomed to degradation. He had a real chance to completely disappear from the face of the Earth, as disappeared many other biological species. Apparently, many populations of our ancestors were on the verge of extinction.

However, the fate of Homo Sapiens appeared different. The man invented agriculture and a little later the cattle breeding, i.e. he began to create artificial biogeochemical cycles - the artificial circulation of substances in the nature. Thus he qualitatively changed his environmental niche and marked the beginning of that civilization which fruits we harvest today and which we owe the difficulties without their overcoming we are unlikely to survive in the world as a biological species.

The process of creating a new environmental niche on the threshold of the Holocene was spontaneous. And the humanity has paid a heavy price for "victory" over the crisis: the Earth's population has decreased probably by many times, not only as a result of hunger, but also devastating uncompromising struggle for resource, first and foremost for the preserved hunting lands.

In fact, only after the Neolithic revolution (i.e., overcoming the environmental crisis) there was a segregation of man from the rest of the Nature - he had ceased to live as other living beings live. Still in the Paleolithic age a man fit well into the usual cycle of matter in nature. After the emergence of agriculture, cattle breeding and then use of minerals he began to intervene actively into its formation, to create artificial biogeochemical cycles, to involve into the cycle the matters accumulated by former biospheres: fossil hydrocarbons, iron and other minerals. And today man has already reached even those energy resources, which appeared on the Earth in the earliest period of its existence as a celestial body - to nuclear energy reserves.

Nevertheless, the ideas of man about his place in the Nature not differ much from those of the man who lived at the beginning of the Neolithic age. The same can probably be said about psychic constitution and level of aggression evolved during the ice ages, when man had to hunt mammoths. And this disequilibrium of the power of civilization and natural

inclinations of the man perhaps is the most difficult challenge that the society has to overcome to ensure its future.

The level of mankind monopolism has increased many times in the last century. The use of the power of civilization to strengthen it turned into a doctrine. Its concentrated expression is a famous statement by F. Bacon that our knowledge and our power have its primary objective of serving the conquest of the Nature. We can add to this the famous sentence by Michurin: "We cannot wait for the mercy of the Nature..."

Thus, in the Holocene age the development of anthropogenesis process followed the line of formation of civilizations increasingly contrasted the nature and society.

Presently, in the beginning of XXI century there is every reason to think that the capabilities of any modern civilizations which fundamentals arose at the dawn of the Holocene and their relevant "world perception of the natural resources consumers" are close to exhaustion. Or maybe already exhausted: the desire for dominion based on the idea of an infinite inexhaustible natural resources has led the humanity to the brink of the catastrophe. This means not only that the new environmental crisis on a planetary scale is inevitable, but that the humanity is facing an imminent civilizational restructuring, reorganization of all our usual fundamentals. Apparently, the mentality of the human and many of the characteristics of his psychic constitution are no longer consistent with his new conditions of living and have to be changed or be exposed to the "malice of winds and weather", otherwise the "upcoming" crisis will result most likely in the extinction of the mankind! Hence, the common sensible STRATEGY for the whole humanity should be opposed to the spontaneous development. That is why the only alternative to the action of the spontaneous forces, if you will, the "planetary market" I see in the reasonable purposeful development of the planetary society, which meaning still has to be decrypted by the people. In any case, the spontaneous self-organization process has to enter into a certain direction with a rather rigid limits.

But before to start talking about society purposeful development, it is necessary to imagine the objective of development and direction of our efforts, to understand the sense of the relations between the nature and society, which is necessary to prevent the catastrophe, the content of their mutual adaptation capable to ensure the continuation of the history of the human race. I think that this problem which gradually resulted in the idea of the noosphere has attracted the attention of thinkers since long time. The first person who pointed the ideas of the age of noosphere was V.I. Vernadsky; the first who said the word "noosphere" was Le Roy; the first who began to discuss widely the features that this age should have was Teilhard de Chardin. By the end of XX century this issue was already covered by multiple works.

3. Conclusion

And progressively the interpretation of concepts "noosphere" and "age of noosphere" has lost its original unambiguity. Today the term "coevolution of man and biosphere" gain a widespread use. The original meaning suggested by Vernadsky and Teilhard de Chardin with regard to the concept of the age of noosphere, in general terms, it seems to me, is equivalent to the notion of coevolution of man and biosphere. Anyway, if a number of subtle aspects are omitted, the condition of coevolution is perceived by us as a prerequisite to save humanity as a part of the biosphere, i.e. human survival on the planet.

On this basis the concept of the age of noosphere can be identified with that time when the state of nature and society will be able to ensure the coevolution regime and the purpose of the modern civilization is to be considered as the formation of society able to implement the conditions of coevolution. Based on the above said, it seems to me that the term "sustainable development" should be interpreted as the STRATEGY of the transition period to such a state of nature and society which we can characterize with the term "coevolution" or the "age of noosphere." In order that such understanding of sustainable development had a meaningful sense, it is still necessary to explain the term "coevolution of the Nature and society." And it’s nowhere near that simple!

The majority of researchers engaged in the environmental problems agree on the fact that the state of coevolution of society and the environment should be based on the need to incorporate the human activity into the stable biogeochemical cycles of the biosphere.? Such state will not be a state of equilibrium in the conventional thermodynamic sense of the word. It will be a quasi-equilibrium which characteristic times have to be so continuous that the society is able to adapt to inevitably changing environmental conditions. In other words, these times should be considerably longer than the lifetime of one generation.

Thereon, common views of the researchers come to an end and even the concept of a natural cycle is not explained, even though it is a very debatable. In addition, the reasoning about the features of the atmosphere age are limited mostly only by general reasoning, which is however no wander as the explanation of the concept of coevolution requires a deep systemic and systematic (not just long-term but permanent) study. And our knowledge of the contents of this phenomenon is still very limited.

This article attempts to apply the general laws of relatively new science – synergetics to the problems of the energy crisis in Ukraine and to the universal human crisis in relations with the Nature; the applicability and predictive nature of the laws of synergetics in relation to the development of the whole human society and Ukraine were established, in particular, the general directions of the human activity in the interests of sustainable development of the whole society for the long term perspective were characterized.

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