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Finance – Energy Balance

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This study addresses the laws and rules of the functioning of contemporary socio-economic systems. Major emphasis is placed on energy as the main component of the existence and development of systems. More accurate notions of commodity and money are given in terms of philosophy. A scheme of the finance-energy balance of a country, a union, a system has been proposed and substantiated. The study analyzes the laws of monetary circulation. The following new notions are introduced: the food-energy budget, based on the well-known notion of energy budget, and the energy for development, as a sum of energy budget and food-energy budget.

Keywords: economics, energy balance, finance-energy balance, economic development, laws of monetary circulation.

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Over the past century, energy and economic crises have occurred several times, either in turn or simultaneously, complementing each other. They start in different countries, subsequently spreading throughout continents and involving the world community. Having gone through a phase of some stabilization, crises occur again and again, with increasing frequency. Representatives of the international economic and political community gather at top-level forums to put forward and discuss various ideas of stabilizing the global economic system, but no effective solutions have been found yet.

Unfortunately, contemporary economics has abstracted itself from the material world, and the financial world has abstracted itself to an even greater extent.

For the past three years, the idea of stabilizing the economy through the recovery of the lost monetary standard, including the use of an energy unit, has been several times proposed at world summits, but has not been developed or supported. Economists and politicians have ignored physicists. The world, however, is primarily based on the laws of nature and only then on the rules invented by Homo sapiens for the human community.

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This study is another attempt to address economic processes in terms of natural science and propose a constructive solution.

Energy as the basis of life

The main and, actually, the only source of energy in the Solar System for the Earth's ecosystem, Homo sapiens, and human community is the Sun. For millions of years, solar energy, via photosynthesis, has accumulated on the Earth as energy stocks. The constant inflow of solar energy keeps the planet ecosystem functioning, which ultimately supports the life of Homo sapiens and human community.

In the economic activity, Homo sapiens use various energy sources to attain the end result. The result usually has the form of commodities: food or other goods, or services such as transportation etc., which are ultimately aimed at supporting and improving the life of Homo sapiens.

The intellectual product occupies a special position. At the present time, it cannot be physically measured and the energy expended on its production cannot be accurately determined. The intellectual product can be treated as an amplifier, programmer, catalyst or, even, detonator of different processes in the community economic activity.

The original source of any kind of energy on the Earth is the sun. Photosynthesis, which is one of the basic processes on the Earth, initiates cycles of carbon, oxygen, and other elements, providing material and energy basis for life on the planet. Photosynthesis forms plants, and then plants and solar energy enable the formation of fauna and Homo sapiens. Photosynthesis is based on the transformation of light electromagnetic energy into chemical energy. This energy ultimately enables conversion of carbon dioxide into carbohydrates and other organic compounds, accompanied by oxygen release. Photosynthesis is a source of

nutrients for all living organisms, also providing humans with fuel (wood, coal, and oil), fiber (cellulose), and innumerable useful chemical compounds. Carbon dioxide and water bound during photosynthesis are responsible for the formation of about 90-95 % of the economic part of the harvest. The remaining 5-10 % is formed by mineral salts and nitrogen taken up from the soil.

Carbon bound in organic substances due to photosynthesis annually amounts to $8 \cdot 10^{10}$ t and the annual production of cellulose reaches 10^{11} t. Owing to photosynthesis, land plants annually produce about $1.8 \cdot 10^{11}$ t of dry biomass, and, although one cannot measure exactly the yield of plants growing in the Global Ocean, it can amount to about the same mass. The contribution of tropical forest reaches 29 % of the total production of terrestrial photosynthesis and that of forests of all types amounts to 68 %. Photosynthesis of higher plants and algae is the only source of atmospheric oxygen – O_2 .

The emergence of the mechanism of water oxidation followed by formation of O_2 , which took place on the Earth about 2.8 billion years ago, was the most important event in biological evolution: sunlight became the main source of free energy of the biosphere and water turned into a virtually unlimited source of hydrogen for the synthesis of substances in living organisms.

The annual increase in the solar energy stock in the form of products of photosynthesis amounts to about $1.6 \cdot 10^{21}$ kJ, and current energy consumption by humankind is about 10 times lower. Yet, photosynthesis uses not more than 0.1 % of the total physiologically active energy of the radiation incident on the Earth's surface.

Fossil fuel (coal, oil, gas, etc.) is also a product of photosynthesis, but this product has been stored for an extended period of time, and annual consumption of fossil fuel at the end of

the 20th century was almost equal to the biomass increment. Thus, **humankind has approached the negative carbon balance on the Earth.**

Other types of energy used in human activity, such as water power, energy of wind, tides, geysers, and other natural forces, are also formed due to transformation of solar energy and the Earth's thermal resources.

A special position is occupied by nuclear energy, but even in this case one can assume that nuclear fission of heavy elements was preceded by nuclear synthesis caused by the sun or a similar source of highly concentrated energy.

These arguments lead to the logical conclusion that energy is needed for anything to occur in the world, especially for transformations performed by Homo sapiens. There is no doubt that all material objects either contain energy or energy has been used to create them. Thus, **“energy component”** can be regarded as the main property of any commodity, product, or service. The energy component is a sum of the energy contained in the commodity – **“energy content”** and the energy expended to produce it – **“energy inputs”**. Depending on the type of the commodity, the energy component can consist of energy content only, for example, in the case of carbon, firewood, electric power, certain food products, etc. On the other hand, it can consist of energy inputs only in the case of primary metal, inert materials, etc. The ratio of the components can vary too, for instance, for goods made of wood, fabrics, plastics, etc., i.e. anything that can burn or be oxidized and release energy. Based on these notions, one can easily determine the minimum life-support value of any commodity as its energy content.

These arguments lead to a definite conclusion: ENERGY is the main and, sometimes, the only property of the commodities supporting life of Homo sapiens on the Earth and, thus, the basis of economy.

Material-informational dualism in the financial system

The contemporary economic system is based on the financial system, which is in turn based on money. The essence of money has not been determined unambiguously so far.

The definition of commodity-money relations was first given by Adam Smith and then by Karl Marx, and many other scholars subsequently used the following definition of money: “Money is some commodity that serves as the general equivalent for all other commodities”. This is the definition of the commodity money. Hence, the theory of money, which defines money as some commodity, has been termed the commodity money theory.

This idea, however, has long been opposed by another one, suggesting that money is some information. The first to express this idea was Montesquieu, and then it was modified to the quantity, nominalistic, state and various other theories of money. These are all different variants of the information theory of money, which is based on regarding money as some information rather than commodity.

In contemporary history the situation with the theory of money is as follows.

In the USSR and other socialist countries, the official ideology was based on the commodity money theory, but it was virtually the information system. The Western doctrine was wholly based on the quantity (information) money theory, but it was actually the commodity system. In both cases, the declared theoretical basis was different from practice.

In the West, the monetary-banking system has always been based on the commodity money theory.

Originally, a market is the place where sellers and buyers meet, trade, and come to terms. However, since the time when stock exchanges were established, “market” terminology has

defined the market as a play area, and sellers and buyers have become players. The goal of any game is to outsmart and deceive the adversary. An essential negative factor in this market play is the presence of numerous money substitutes in the form of securities. Thus, the main reason for the contemporary economic crises is most certainly the disproportion between the play money supply and the quantity of actual goods in circulation.

The socialist administrative monetary-banking system was actually based on the informational character of money. Special calculations determined what and how much a Soviet human needed for his/her life support, the content of his/her basket of goods was priced, and salaries were fixed accordingly, their range being very narrow for different groups of society or rather wide for the select few.

In the monetary sphere, there was a fundamental discrepancy between theory and practice both in the capitalist (Western) world and in the socialist society.

Under current conditions, the issue of resolving the material-informational dualism in commodity-money relations is becoming increasingly urgent for both philosophical and practical purposes, but no understandable and practicable solutions have been proposed yet.

Based on the conclusion about the interrelationship between the commodity and energy, one can logically derive a notion of commodity:

Commodity is an object or an aggregate of objects necessary for Homo sapiens to develop, or an object plus information.

Thus, the notion of commodity now unites and determines the interactions between the matter, energy, information, and Homo sapiens. The definition of commodity unites two notions: object and information. The components matter and energy define it as an object. The informational component, as a property of the

object, determines the degree to which it is necessary for Homo sapiens.

In order to exchange goods, to allow the property rights to be transferred from one human to another, to produce new goods, to create new objects and living conditions, and, generally speaking, to let humankind develop, Homo sapiens in different parts of the world invented an equivalent for commodities – money.

Based on the fact that both commodities and money are derivatives of the activity of Homo sapiens and are necessary for Homo sapiens only, within the framework of the above arguments, I propose the following definition of money:

Money is a universal property of the commodity, which corresponds to the degree of its being necessary for Homo sapiens. It cannot exist without commodity or Homo sapiens.

The development of the above argument that the main and, sometimes, the only property of the commodities circulated by Homo sapiens is energy, suggests an equally indisputable conclusion that **the two properties of commodity – energy as a physical property and money as an informational one – are UNITED.**

Thus, under current conditions, material-informational dualism in commodity-money relations can be regarded as an anachronism. As for the financial systems based on either commodity or information doctrine, they are doomed to degradation, which has been confirmed by the contemporary history of financial crises occurring in countries with different state and political systems.

Money theories, laws, and monetary standards

To develop these arguments, it would be reasonable to consider and briefly analyze the basic theories of money, which were put forward as early as 16-18 centuries, during the genesis of classical political economy.

Money theories

The metallistic money doctrine was developed in the early period of contemporary history and played a progressive role in the struggle to prevent debasing of coins (a reduction in the precious metal weight). The most significant part in its advancement belongs to mercantilists, who developed the doctrine of metal coins of full value as national wealth. Metallists' mistake was that they equated money to goods and did not understand the difference between circulation of money and commodity exchange. Representatives of the metallistic theory denied the possibility of substitution of the token money for metal money of full value in the domestic circulation.

The nominalistic money doctrine was developed by critics of mercantilism, who negated the commodity nature of money. Its representatives argued that money is just a token, which has nothing to do with the goods. Nominalists focused on the analysis of the functions of money, as a means of circulation and an instrument of payment, allowing a replacement of metallic money by paper money. The main mistake of advocates of the nominalistic theory was that they negated the commodity nature of money. Whereas suggestions based on the metallistic theory hindered the introduction of paper money, nominalists' proposals could cause inflation buildup.

The quantity theory of money stated that the quantity of money should influence the level of commodity prices. Its early representatives were C. Montesquieu in France and D. Hume in England. In the 20th century it was developed by J.M. Keynes in Great Britain, I. Fisher in the USA, G. Cassel in Sweden, M. Friedman in the USA, and other economists. The quantity theory of money establishes a direct relationship between the increase in the quantity of money in circulation and a rise in commodity prices.

M. Friedman, the leader of monetarism, one of the main lines in the contemporary neoclassical economic theory, argued that any government intervention in the circulation of money is fruitless and harmful. Hence, the main suggestion against government intervention in economy is to keep the quantity of money increasing at a steady rate (about 3 % a year), irrespective of economic conditions.

Laws of monetary circulation

The functioning of money is supposed to obey certain objective principles. The basic ones have been formulated as K. Marx's law, the Copernicus law (Gresham's law), the Fisher equation, and the Cambridge equation.

K. Marx's law of monetary circulation is expressed by a basic equation, determining the main parameter, **M** – quantity of money.

$$MV=PT$$

The Copernicus law – Gresham's law was formulated in the 16th century almost simultaneously and independently by Nicolaus Copernicus, a Polish thinker, and Thomas Gresham, an English financier. The law states that if there are two forms of money in circulation, "bad" money drives "good" money out of circulation. People will use more stable ("good") money as a means of hoarding and, thus, take it out of circulation. Money that has unstable value, debased ("bad") money will be used in transactions and for payment.

The Fisher equation is named after Irving Fisher, an American economist. This equation describes the factors determining the quantity of money necessary for normal functioning of market economy. The equation has the following form:

$$M \times V = P \times Q.$$

The Cambridge equation was formulated in the 20th century by Arthur Pigou, an English economist. It has the following form:

$$M = k \times P \times Q,$$

where **k** is the portion of the product (**P** × **Q**) that will be held as liquid assets, **V** is the velocity of money, **P** is the price level, and **Q** is the quantity of goods sold.

Similarly to the Fisher equation, the right-hand part of the Cambridge equation shows money demand and the left-hand one – money supply.

K. Marx's law, the Fisher formula, and the Cambridge equation only provide guidelines for the answer to the most important question of the market system: How much money should be issued to ensure normal economic development? All of them, however, have two drawbacks: there is no monetary standard and their statistical data are subjective.

Regulation of money circulation. Monetary policy is the regulation of money supply to curb inflation, to reduce unemployment, and to stimulate economic growth. It is based on the ability of the monetary and credit system to exert significant influence on the solutions to problems of macroeconomic instability.

The policy of “expensive money” is conducted to control inflation. A reduction in money supply causes a rise in the loan interest rate. This can lead to a decrease in the inflation rate, at the same time, reducing investments and increasing unemployment.

The aim of the policy of “cheap” money is to stimulate economic growth. Money supply is increased and the loan interest rate decreased. The loan becomes more affordable, investments and employment increase. However, the disadvantage of this policy is higher inflation rates. The main regulator of money circulation is the central bank

of a country. To increase the quantity of non-cash assets, more loans should be given, without having to print more money.

The central bank uses three main approaches to monetary regulation:

1. Discount policy – a change in the discount rate.
2. Open market operations.
3. Changing legal reserve requirements.

These instruments are used to reduce or increase the quantity of money. This is how the central bank regulates the investment flow, the inflation rate, national currency rates, and, ultimately, the growth rate of gross domestic product and the employment level.

Monetary standards. Gold and silver proved to be the most suitable materials to function as money.

In 1944, the United Nations Monetary and Financial Conference held in Bretton Woods (USA) established the international monetary system. The Bretton Woods system was based on an interstate financial gold standard currency.

The Bretton Woods system had the same set of elements as the gold standard, but that was a transitional system. Gold was still a standard of value, but US dollars were used as the world's new reserve currency. Until 1952 gold had been almost solely used as bank reserves. Gold backed the US dollar, deficits in the current accounts, and intervention.

The Bretton Woods system was followed by the Jamaica monetary system, agreed upon by IMF countries at a meeting in Kingston (Jamaica) in 1976.

In April 1978, after the IMF countries had ratified this agreement, the IMF statute was altered. As the USA position in the external market became weaker as a result of reduction in gold reserves of the country, in 1971 – 1973 the international monetary system based on the

US dollar's fixed value against gold collapsed. The US dollar was no longer the only reserve currency. The FRG mark, the Japanese yen, the British and Swiss pounds, and, more recently, SDR, ECU, and Euro also acquired the function of reserve currencies. ***On August 1, 1971, dollar's convertibility into gold was suspended*** and the fixed dollar price of gold was cancelled officially.

ECU became a basket of currencies for the European Monetary System (EMS) member states in March 1979. ECU was a paperless unit used in accounts of central banks of the EMS member states. ECU was later replaced by Euro, also without an exact standard.

In order to alleviate the problems of international liquidity, the International Monetary Fund created a ***Special Drawing Right*** (SDR). The SDR value was initially determined by the price of gold in US dollars (US\$ 35 per ounce at that time). In 1976 it was defined on the basis of the currency basket of 16 countries. In 1981, the SDR unit was defined as a weighted sum of contributions of five major currencies: the US dollar, the German mark, the French franc, the pound, and the Japanese yen.

The contemporary monetary system of Russia functions in accordance with the Federal Law on the Central Bank of the Russian Federation of April 12, 1995. The basic monetary unit (currency) is the ruble. There is no legally fixed price of gold in rubles.

It is evident that AT THE PRESENT TIME THERE IS NO MONETARY STANDARD IN ANY COUNTRY OF THE WORLD!

In the analysis of the history of theoretical foundations for the contemporary monetary system, one cannot ignore the practical conclusions made by the most prominent historical figures.

The significance of monetary policy was emphasized by J.M. Keynes, an English economist: "There is no surer means of

overturning the existing basis of society than to debauch the currency." (1883-1946)

"All the perplexities, confusions, and distresses in America arise, not from defects in their constitution or confederation, not from a want of honor or virtue, so much as from downright ignorance of the nature of coin, credit, and circulation." said John Adams, the second President and the author of the Constitution of the USA (1797-1801).

M.A. Rothschild, a banker, expressed it in an even more definite way: "Give me control over a nation's currency and I care not who makes its laws." (1743-1812)

Careful analysis shows that the parameters constituting the laws considered above are based on subjective statistical data, and their main parameter – the quantity of money – is purely subjective. As the quantity of money is determined by the government or the ruler, the laws of monetary circulation depend on the person signing the document that starts money emission or on the interested party.

Hence, we arrive at Aristotle's conclusion: MONEY CAME ABOUT THROUGH AGREEMENT, NOT BY NATURE, BUT BY LAW.

The analysis described above suggests the following conclusions:

- 1. Money is a universal property of the commodity, which corresponds to the degree of its being necessary for Homo sapiens.**
- 2. There is no monetary standard in any of the states of the contemporary world.**
- 3. The two properties of commodity – energy as a physical property and money as an informational one – are UNITED.**

These conclusions logically give rise to the idea of the FINANCE-ENERGY BALANCE.

Finance-energy balance

The idea is based on three fundamental principles:

1. **The law of conservation and transformation of energy:** *“The total amount of energy in an isolated system, whatever the processes occurring in the system, remains constant over time. Energy can only be transformed from one state to another and be redistributed among different parts of the system.”*
2. **The law of the equivalence of mass and energy:** ($E = mc^2$ A. Einstein)
3. **The main instrument of economy is MONEY**

THE MAIN PURPOSE OF THIS IDEA is to achieve sustainable, crisis-free development of the economic system (of a country and the world) by employing the principle of strict correspondence between the quantity of circulating commodities and the quantity of money in the system.

The balance between energy and money in a country, a system, or the world can be addressed in terms of a more general science – ecology.

Further arguments require a definition of ecology, and E. Haeckel’s seems to be the most appropriate, although it was written at the time when biology was a purely biological science.

“By ecology we mean the body of knowledge concerning the economy of nature—the total relations of the animal to both its inorganic and organic environment. In short, ecology is the study of all those complex interactions referred to by Darwin as the conditions of the struggle for existence.”

To show the main idea, I propose presenting the major interrelationships as a scheme of the finance-energy balance of a country, a union, a system.

The economic potential of any country, union, or system comprises the following principal components:

- the territory receiving solar energy, which has stored energy resources and renewable energy sources;
- economically active population – human resources;
- active portion of the national wealth – production facility;
- national wealth – created and accumulated components of the sphere of human activity;
- intellectual (scientific, administrative) population, capable of advancing all the components listed above.

In what follows we will use the following terms:

The energy for development, E_m – the energy transformed and utilized by the economy of a country, a union, or the world.

The energy for creation, E_c – the energy used to increase national wealth and improve the conditions of human activity.

The energy for destruction, E_d – the energy used to destroy the sphere of human activity (war, destruction of the ecosystem, etc.).

The contemporary system cannot exist and develop without energy for development and its two components: the energy for Homo sapiens (food) and the energy for economy and production (fuel, electric power, etc.). The energy for economy and production is usually measured in tons of equivalent fuel or terajoules. The conversion to equivalent fuel (EF) is conducted by multiplying the amount of certain fuel by a so-called heat ratio. Electric power generated by hydroelectric and nuclear power plants is converted to EF based on the following estimate: 1 TEF = 2000-3000 kWh (depending on the efficiency of the power plant). The annual consumption of electric power by

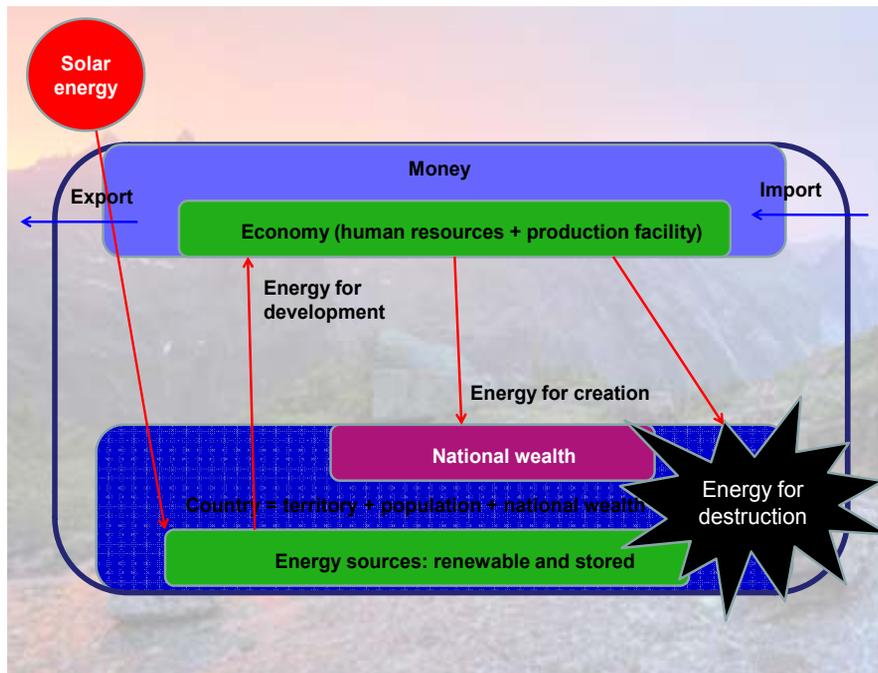


Fig. 1 A scheme of the finance-energy balance of a country, a union, a system

the country's economy is usually calculated as energy budget (EB).

As food balance will be calculated in the same units as **EB**, it seems reasonable to introduce the notion of food-energy budget (**FEB**). Thus, the energy for development can be presented as a sum of the two values: $E_m = EB + FEB$

The scheme in Figure 4 is an illustration of the following:

1. The main source of the inflowing and stored energy is the Sun.
2. The energy for development is the energy involved in economy: $E_m = EB + FEB$.
3. The energy for creation is the energy used to create the conditions for human activity and develop its constituents. This is the difference between the energy for development and the energy for destruction: $E_c = E_m - E_d$.
4. The energy for destruction, E_d , is the portion of the energy for development with destructive functions: deterioration of the

territory, war and any other activities that destroy energy sources, national wealth, population, etc. Importantly, the energy used to destroy another system also destroys its own system.

5. The export-import energy balance determines the degree to which the system depends on external systems.
6. The development, stability, and security of the system of a country or a union are determined by the reserve, amount of transformed energy and the export-import balance.

As, in this case, money is defined as a universal instrument of commodity circulation and, hence, energy circulation, interactions between the major components of the system can be presented as occurring via monetary circulation, but the contemporary monetary system has two drawbacks that do not allow one to do this:

The first drawback is that there is no monetary standard.

The second is that the laws of monetary circulation are subjective.

Computer model of economy

At the present time, the functions of modern supercomputers enable accurate and detailed simulation of almost any natural process. Economic processes can even be modeled in real time and space, on a global scale. The question arises: Why has not it been done yet?

Numerous attempts to construct accurate mathematical models of the economy of a country, a union, or the world have not been quite successful due to the lack of a pivot (a reference point), because of the drawbacks mentioned above.

In contemporary ecology and economy, energy can serve as a pivot and any mechanism of its transformation, including money, can be a lever.

A real-time computer model of energy fluxes inside the system would enable very accurate control of the economy of the system as a whole.

The proposed solution

Based on the above arguments and the conclusion that the two properties of the commodity – energy as a physical property and money as an informational one – are united to make a universal instrument of commodity circulation and, hence, energy circulation, expressing the monetary unit ΔM as an exact physical quantity, in the general form $\Delta M = \Delta E$ (e.g., **1 Ruble = 1 kWh**), and expressing the energy of development, E_m , as a sum of the annual energy and food-energy budgets (**EB** and **FEB**), $E_m = EB + FEB$, **I suggest expressing the law of monetary circulation as the following system of equalities:**

$$\begin{cases} \Delta M = \Delta E \\ M = E_m \end{cases} \quad \text{or differentially:} \quad \partial M / \partial E = 1$$

where ΔM is a monetary unit, ΔE is an energy unit, M is the quantity of money, E_m is the energy for development ($E_m = EB + FEB$).

The monetary unit can be compared to the standard at any point of payment, for example, for the standard **1 Ruble = 1 kWh** – at the point where the electricity meter is installed. The cost of any commodity acquires a standard value as its own energy content and the energy expended to produce the commodity.

The equalities $\Delta M = \Delta E$ and $M = E_m$, as an absolute prerogative of the government of a country, a union, or a system, are established and controlled exclusively by the state.

The mission of the proposed solution is:

- 1. Construction of an extremely accurate real-time computer model of the economy of a country, a union, the world.**
- 2. Control of the stability of the economic system in a country, a union, the world.**
- 3. The world leadership of the country initiating modernization of the global monetary system (creation of new universal international currency).**
- 4. Stability of social guarantees such as 1 kWh = 1 Ruble; 1 liter of petrol = 8 Rubles; 1 loaf of bread = 10 Rubles; stable municipal rates; etc.**
- 5. Accurate implementation of the national budget in internal and external payments.**
- 6. Development of the positive aspects of the system: environmentally friendly energy, ecological balance, rational economy, comfortable conditions for human activity, humane policy.**

Финансово-энергетический баланс

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В предлагаемой вниманию работе представлен анализ применяемых в современном мире законов и правил жизнедеятельности социально-экономических систем. Выделена роль энергии как главной составляющей существования и развития жизнедеятельности систем. В философском аспекте предложены уточненные понятия товара и денег. Предложена и обоснована схема финансово-энергетического баланса страны, союза, системы. Дан анализ известных применяемых законов денежного обращения. Предложено ввести понятие продовольственно-энергетического баланса – ПЭБ в соответствии с известным понятием топливно-энергетического баланса – ТЭБ и энергии развития – Ер как суммы ТЭБ + ПЭБ.

Ключевые слова: экономика, энергетический баланс, финансово-энергетический баланс, экономическое развитие, законы денежного обращения.
