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R.S. Syrlybayev, G.V. Stulnikov, A.M. Soltanayev, T.N. Agimov

Almaty University of Power Engineering and Telecommunication,
Almaty, Kazakhstan

ENERGY AND POWER ENGINEERING. PHENOMENON, DEFINITIONS, RESOURCES AND SOURCES, VECTOR OF DEVELOPING

Energy is present in the expanses of the Universe and in the bowels of the Earth. Its flows pervade the space. The lives of people and their material well-being directly depend on energy availability and the country's wealth from energy resources. At the same time, in the scientific literature, textbooks for technical universities, there are discrepancies, confusion in terms and definitions on this topic and no definition about energy. Based on the analysis, offered a clear and precise wording. It is necessary to strictly delineate the concepts of "forms of energy" and "types of energy", they are mixed even by venerable authors. The form of motion of matter determines the form of energy. Within each form of energy (motion) there are two types of energy. Potential energy "promises" the work, kinetic – it turns into it. In the modern list of forms of energy are 14 items. It probably is not the final one. It is assumed the existence of a vacuum energy inherent in the vacuum of space as the form of matter. It is underlined: increasing loads on the Nature (greenhouse effect, adding energy). The reserves of traditional fuel are depleted and the issue of the transition to the Green Energy is more acute.

Keywords: energy, forms and types of energy, conditions of energy conversion, traditional sources of energy, Green energy.

The well-being of people and society depends on the energy security, disposable and involved energy resources. The derivative here is the level of development of culture, sciences, arts, health and sociality. No any processes, movements are impossible without the expenditure of energy. Perpetual motion machine is not feasible and the energy is never enough [1, 2, 3, 4]. Table 1 serves as an illustration. Experts believe that the energy needs of developed countries will grow by 1,3 times by 2020 compared to 2000. The consumption of oil in them grows by 1 % per year, and in developing countries it increases by 2 % over the same period. The table provides data on per capita consumption (as an indicator of the quality of life of citizens) of electricity in some countries.

Forecasts say that per capita electricity consumption in developed countries will exceed the global level by 3,55 times in 2020. The highest per capita consumption is expected in Canada – 18,7 thousand kWh and the USA – 14,7 thousand kWh. At the same time, more than 2 billion people in

Africa, Asia, Latin America (more than 30 % of urban and up to 90 % of the rural population) receive heat for heating their homes and cooking food from burning the wood. At the same time, forests or "the lungs of the Planet" are suffering by this reason [4].

With such a great significance "energy" phenomenon, paradoxically, it is still not clearly formulated, what is it? There are no defined approaches to its classification as a universal phenomenon. I.S. Kogan made a scrupulous analysis of the issue (2009) [5], many citations are given, references are given by authoritative scientists (Ozhegov, Fedorov, etc.) and publications (Physical Dictionary, Polytechnic Dictionary, etc.). The concept of "energy" is ambiguous and in the presented study, it is considered only from a technical point of view.

In this context, analysts essentially are unanimous: "Energy – one of the fundamental properties of matter, the general quantitative measure of motion and interaction of all matter. Energy does not arise from nothing and does not disappear, it can only transform from one *form* to another". In accordance with various forms of motion of matter, various forms of energy are considered: mechanical, internal, electromagnetic, chemical, nuclear, etc. [5].

Dynamics and forecast of per capita net electricity consumption in the world, thousand kW · h [4]

Country	1990	2000	2010	2020, forecast	Total growth in 2001–2020, %
Industrially developed countries, including:	7,2	8	9,2	10,3	28
USA	11,1	12,2	13,5	14,7	20
Canada	15,6	16,6	18,2	18,7	13
United Kingdom	5	5,6	6,7	7,3	30
Germany	6,2	6,1	7,4	8,6	41
France	5,7	6,9	8	9,2	33
Japan	6,2	7,5	8,6	9,8	30
Developing countries, including:	0,57	0,91	1,5	2,3	153
China	0,48	0,85	1.14	1,5	76
Russia	6,2	4,9	5,9	7,4	51
The world as a whole	2	2,13	2,5	2,9	36

Modern scientists repeat these thoughts. "Energy is a general quantitative measure of the motion and interaction of all kinds of matter ... The concept of energy connects all the phenomena of nature. In accordance with various *forms* of motion of matter, various *types* of energy are considered: mechanical, internal, electromagnetic, nuclear, etc." [6]. In the BSE (3rd edition, v. 30, 1978) can be found: "Energy- general quantitative measure of motion and interaction of all *types* of matter ... it moves from one

form to another. In accordance with various *forms* of motion considering various *forms* of energy ...". From the review are visible vagueness in the formulation of the term, and some confusion in the application of the concepts of "form of energy" and "type of energy" (Italics in quotations – our). It is observed in the "old" [5, 7], and "new" [3, 6, 8] authors' works.

From the above definitions, it is not clear what the "energy" is? There is no answer to the question in essence, only reference to the circumstance related factors.

The answer to this "problem" lies on the surface, or rather in the word "energy", it is of Greek origin. "Erg" means – the root of the word "work", there was such a unit of work-energy. Establishing this term, scientists (in particular T. Jung) obviously was intended to emphasize the *essence* of the phenomenon.

The most adequate seems to be the forgotten wording: "Energy is "storage" of possible, but not yet performed work" [7]. That is ability of body to generate external impacts [8]. Systems can be mechanical, thermal, electrical, chemical, etc.

Speaking about of energy, its circumrotation not to mention the entropy, integral it is "shadow" [2, 6, 7]. One of the interpretations of this term – is a measure of energy dissipation. As processes occurring in nature, the technics is accompanied by friction and heat transfer, then entropy increases, this has led some authors to conclusions about the warming of the universal matter, the alignment of the temperature and, accordingly, the fading processes of energy exchange. As a result, it would mean "Heat death of the Universe" (R. Clausius). The universe, in their opinion, should "die" from "heat stroke". Give the evidence to the contrary, the impossibility of this situation. The proponents of this theory did not take into account the infinity of the universe and the processes of conversion, dissipation and concentration of energy should fluctuate, interspersed in space and time. Otherwise it is impossible to explain the presence of energy reserves on Earth (non-renewable and renewable), in the Solar system in Space. About separately taken planet Earth: green flora, "working" and photosynthesis do not stops, it takes a special prominent place on our planet (perhaps in the Galaxy). Radiant energy of the Sun is converted, concentrated and stored by green plants. It turns to the chemical energy of green mass of "organic" synthesized chlorophyll from water and carbon dioxide. Entropy decreases – it is a private remark to the question of its growth. People have learned to accumu-

late and release enormous energy for creativity and for destruction of matter and turning it into chaos. Extract pure chemical elements, receiving, and storage of energy – all this reduces the entropy of our environment. In the organisms of herbivorous and carnivorous animals and humans, entropy continues to decrease in the process of digesting food. A gift to mankind from nature and should be considered a unique property of the plant after the "death" turn into mineral resources. Hydrocarbon deposits (as they are now called), is «concentrate» of solar energy which is accumulated millions of years ago. Green flora to combat with entropy use powerful tool – sunlight, with his participation in the chlorophyll occurs the photosynthesis process, effectively increasing the orderliness of degraded substances, and everything is repeated. It is a unique natural spontaneous process for earth in which entropy decreases.

Regarding the use of the terms "forms" and "types of energy". As shown above, these concepts substitute for one another or used interchangeably in metrology, and in the technical sciences. This situation leads to confusion and misunderstandings [5]. Obviously, these terms need to be clearly defined, to give them concreteness. According to the lexical rules of the language, the form – a concept more encompassing and the type – the notion of concise narrow. Consequently, the form may include types. Is necessary to talk about the *forms* and *types* of energy in this context. Obviously, each particular *form of motion* corresponds to the specific *energy*: *mechanical, thermal, electrical, chemical, nuclear, gravitational*, etc., In the end, the *form of motion* of matter determines the *form of energy* that will be involved in the process of conversion. Scrupulously and repeatedly conducted experiments confirmed the quantitative correspondence of different forms of energy. (Before the SI system was introduced in technical thermodynamics, the mechanical equivalent of heat was mentioned – 1 kcal of heat equal to 427 kilograms of mechanical work). Theoretically, the conversion of energy, for example chemical, with the exception of the "thermal stage" is possible with an efficiency of about 100 %.

Inside of the energy forms are exist the types. In nature there are *two types of energy – kinetic and potential*. There are two subtype of potential energy:

– *position* – measured by a change in coordinates of the body in some physical field (figure 1 in this illustration);

– *internal* (*in the thermodynamic sense*), and *strain energy* – it is due to the stresses and strains in a body by force field.

Within any *form* of energy its *types* can transform into one to another. That is, the change in the content of energy in the system indicates the energy exchange occurring within the boundaries of some form of movement.

Traditionally, it happened in the process of development of sciences, "kinetic and/or potential energy" refers to mechanical form. However, even Leibniz wrote (about 1700): "It is wrong to reduce the diversity of nature to the pure mechanics...". In all experiments, and natural phenomena, it is hard (for half a century before Mayer) sought confirmation of his thoughts about the permanence of "living forces".

Now the energy of the moving body, the system (departing from the tradition of the "system" must be understood in the broadest sense) is called the kinetic, and the energy of the system "promises" to make the movement-potential. This should be considered as macro, - and micro, - nanobody].

To say about "kinetic" and "potential" energy should obviously not only in the application to the mechanical form of motion. Types of energy should be considered in the broad sense, these adjectives are applicable to any form of motion (energy). Do not say, for example, "electrical kinetic energy", just say simply "electric energy" or "electric current" (which already implies kinematics) or a lapidary quite "current". But sometimes, the potential electrical energy (e.g., in storm clouds, in nature it accumulates an electric eel and uses for protection and attack). Such examples could be multiplied regarding other forms of energy. So, the potential chemical energy is result of the activity of the Sun and photosynthesis, which stored millions of years in the form of hydrocarbons.

Obviously, for the types of energy applicable expressions such as: energy of phase "sleep" under the appropriate technical effects (or without them) can go to the "active" phase. After passing this stage the energy can change form.

Despite the rather long list of forms of energy [5, 7, 8] (more on that later), there are only two ways of energy transfer through work (here not only mechanical work) and process heat transfer [3, 6] *Warmth – a special unique form of energy. Heat transfer takes place (heat conduction, convection, radiation) bypassing the stage of work*.

It should be emphasized: conversion of forms of energy takes place through work, mutual transformation of types is without that degree.

Mutual conversion types of energy within one form of movement can be demonstrated on the example of a dam hydropower plant. For the effective functioning of hydroelectric power station it is necessary to provide the volumetric flow rate of water Q (a pass in a unit of time) and the upstream level H (figure).

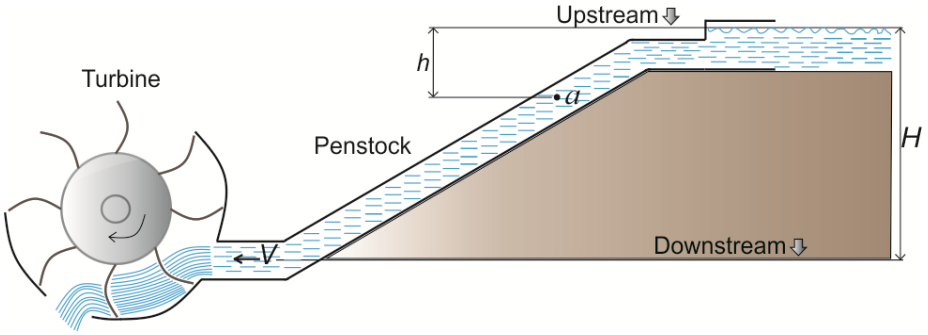

Fig. The mutual transformation of mechanical energy types of the water flow

The volume of water accumulated in the upper reservoir to the upstream (U) possesses a store of *potential* energy P_{pu} (relative to the downstream (D)), the potential energy of the volume of water Q (m^3/s) will be

$$P_{pu} = \rho Q g H = mgH, \quad (1)$$

where ρ – the density of water, kg/m^3; g – acceleration of gravity, m/s^2; H – the height of upstream, m; m-mass flow rate of water, kg/s.

With the overthrow of the mass of water m in the penstock to the hydroelectric units, its potential energy "flows" (literally) into kinetic energy due to flow velocity V

$$P_k = mV^2/2, \quad (2)$$

since $V^2 = 2gh$ (h – is the opposite of upstream datum for height), then

$$P_k = mgh. \quad (3)$$

At any point in the flowing stream a the amount of the potential $P_{pa} = mg(H - h)$ and kinetic $P_{ka} = mgh$ energy is constant (ignoring dissipation)

$$P_{pa} + P_{ka} = mg(H - h) + mgh = mgH = P_{pu} = \text{const}. \quad (4)$$

On the downstream $P_к$ is maximal, because $h = H$ and can be write $P_{кd} = P_{pu}$ – the law of conservation of energy in action. The kinetic energy of the $P_{ки}$ is used for further energy production of hydroelectric units.

So, the body (some volume of water) at a height of H had some potential to commission work, the water must be brought down from a height. That is, the volume of water of mass m at a height H has potential energy (energy of position) mgH. After falling to the level $H = 0$ ($H = |h|$) the potential energy become zero, but the energy has not disappeared, it has acquired a new quality, characteristic velocity V, ($V^2 = 2gH$). Now, possessing kinetic energy the body can do the work.

In summary: the mechanical work will be done when change the "energy status" of the body with potential energy to kinetic energy. Similar reasoning can be repeated for other forms of movement, of energy. The willingness of the body (system) to perform work, its energy potential is inextricably linked with motion. Not necessarily it will be directly perceived by human senses the movement of macroscopic bodies. Indeed, the basis of any form of energy is mechanical movement energy carriers (On the level of micro - and nanobody: the movement of electrons, ions, molecules of gas or liquid and on the level of macrobodies: the displacement of solid objects, mass of gases and liquids, the movement of the planets, stars, etc.) [5]. It is believed, for example, that heat is due to the intensity of the random motion of molecules and atoms in the physical body. By technical means this chaos can be somewhat streamlined and to the macroscopic manifestations for many centuries (steam machines, internal combustion engines, etc.). More examples: electrical energy stored in the battery is potential. When you connect it to the network it is a movement of anions and cations is given a current user, here we can talk about kinetic electric energy (a bit unusual phrase). In the battery when switching from sleep mode to the desktop is changing "status" of chemical energy. The thermal energy stored in thermos accumulating - potential, transported the same coolant and involved - kinetic (the subject of thermodynamics).

List forms of energy correlative forms of movement, including all possible options (for this time) conversion of energy on the Earth. This list has 14 titles which are known by humanity:

– electric;
– chemical;
– electromagnetic;
– thermal;
– electrostatic;
– mechanical;

– nuclear (thermonuclear);
– gravistic;
– gravidynamic;
– neutrinostatic;
– magnetostatic;
– neutrino-dynamic;
– elastic;
– annihilation.

This list has not been updated in over half a century.

It is believed that the vacuum of space as the form of existence of matter inherent in the "vacuum" energy [4] and energy of black holes.

The practical significance of the applicability of the listed forms of energy is very different. They are evaluated by many characteristics [1, 2, 4, 5, 9]:

– the possibility of direct use;
– opportunities to economically transported over long distances;
– the presence and size of resources on the Earth;
– the ability to renew these resources;
– the opportunity to accumulate and be preserved;
– ability economically to turn into forms to be used;
– the speed of transformation into other forms;
– concentration, etc.

Nature has predestined a fairly narrow range of non-renewable energy resources (extracted minerals) and renewable energy sources (RES). From the latest nature and humanity directly uses mostly solar radiant energy. Because of the sun, its electromagnetic radiation, light on the Earth there is lush vegetation, which feed on the herbivores and then by trophic chains. Also, the tiny part of the energy of oceans, seas, rivers, wind, heat of the ground and water consumed by us in the "natural" form, without transformation into intermediate forms of energy.

Mechanical, chemical, thermal, electromagnetic (light), nuclear energy forms play the role of primary sources (resources). Most often involve secondary forms of energy are, again, mechanical, thermal, and electromagnetic and electric. Electrostatic, gravistatic, magnetostatic form of energy used to create energy reserves. There are noteworthy to say about chemical energy, because it is accumulated in enormous amounts in the world's deposits of hydrocarbons and continues to accumulate in the photosynthesis of

plants (peat). It being in the "standby mode" is achieved in the batteries of vehicles is accumulated as a reserve in the batteries of wind and solar installations. It is involved in fuel cells.

The immutable laws of Nature state: gaining energy, suitable for use only (no alternatives) through conversion from other forms. Most popular "applied" forms of energy are:

– electromagnetic (light). Light energy – part of the spectrum of solar radiation is necessary for all living things. Efficiency of the process of photosynthesis in green plants, they lie at the beginning of the trophic chains, less than 0.5 %. The fastest and most effective photosynthesis is possessed by so-called C4 plants, including amaranth, sugarcane, millet, corn and chinese reeds. For the period of vegetation, the efficiency of photosynthesis in them reaches 3–5 % [8].

In fact, all of its "conscious" history (to the twentieth century), mankind received light by burning (oxidizing) solid (wood) or liquid (oil, vegetable oils) hydrocarbons. And in incandescent light emits by hot tungsten filament. Note: here there is an extra level (thermal) in obtaining "applied" energy.

Electric lighting and irradiation devices are used in the dark at the time of the day and in the implementation of various technological processes for the purpose of illumination and irradiation. The efficiency of these devices is small, for an incandescent lamp, for example, the real light efficiency does not exceed 3.5 %. Modern lighting technology offers lamps of cold (in terms of temperature) glow. For luminescent lamps and light-emitting diodes the efficiency value is already 12–15 % but it is low. Although taking into account the fact that no more than 5–10 % of the total generation is consumed for lighting purposes, the absolute losses of electricity here are relatively small.

– mechanical, it is necessary to perform technological processes in industry and agriculture, for the movement of vehicles and just "way of being" of living organisms is associated with the cost of mechanical energy. Mechanical energy is easily and efficiently converted to electric. Transmitted to a distance of not more than 10 m;

– heat, it is necessary, again, for making technological processes in industry and agriculture, in the home - for cooking and other purposes. The heat required is, say, without equivocation, for the survival of humans and

animals in a cold climate. In the working cycles of thermal power plants (TPP), which is the basis of world energy, heat is the intermediate step in the production of electricity. The boilers of the plant are burned, non-renewable fossil hydrocarbons. The chemical energy of fuel is converted here on the chain in thermal – mechanical - electrical energy. It is inadvisable to transfer thermal energy (in the form of hot steam and water) through pipelines for distances over 20 km. To supply power to autonomous units, e.g. vehicles, they are installed most heat engines (steam, internal combustion and gas turbines).

– nuclear energy. Nuclear power plant (NPP) in fact is the same as TPP, in their "pot", "burn" nuclear "fuel". Now the "peaceful atom" finds wide application in the energy sector. 80 % of electricity in France is produced by nuclear power plants (NPPs), in Belgium is 75 %. Japan is depend from nuclear power, despite the memorable catastrophe in Fukushima. Powerful nuclear powerplant works on larger seagoing vessels, miniature – in space. The energy content of nuclear fuels is very large. So, 1kg of uranium-235 "gives" 6,7·1010 kJ. Thermonuclear fuel - the hydrogen isotopes deuterium and tritium has the energy of 7–10 times higher. (1 kg traditional hydrocarbon "will give" (2–4)·104 kJ). Peaceful fusion isn't possible because of the high temperatures of the process (tens of millions of Kelvin) and pressures (thousands of bar). In hydrogen bombs, such parameters are achieved nuclear "fuse". Driven "fusion" fails for over 55 years, but doubtless there are prospects, experts say. And when that happens, people will receive the Ocean (in the literal sense of the word) of energy. Because the deuterium contained in 1 l of seawater is equivalent to 160–200 liters of oil fuel.

– electric, it is the basis of modern civilization. Without electricity is unthinkable in the life of humanity. It is needed in the industry to drive mechanisms and machines and ensure the technological processes, in agriculture, in the home (it is interesting to calculate how much each house, workplace lighting and motors) and transport. The functioning of means of communication, information and media systems is impossible without electricity. Electrical energy is easily and effectively with small losses are converted into "popular" application form (mechanical, thermal, lighting) and others are less popular. It can be transported over distances measured in thousands of kilometers. Major drawback - the problem with the accumulation of large quantities;

– and chemical energy refer to the "application" (in this issue have different interpretations), if only because it is present in the food - production animals, and in the urgent food person. It, thanks to metabolism, is for us a storehouse of energy and a pledge of energy.

Summarizing: so, in our time, in amounts large and small electricity seems to be a very popular and convenient form of energy. World energy demand by 75–80 % is covered by thermal power plants, burned in their boilers of non-renewable fossil hydrocarbons. However, stepped process of conversion of energy carried by TPP is not rational. Efficiently convert chemical energy carrier into electricity, bypassing the "calorific value" stage (its efficiency is small – 35 %) – for example, in fuel cells, thermionic and thermoelectric plants, nuclear power electric batteries. This are a wide field for research. Electricity with high efficiency is converted into work.

There are predictions that energy demand worldwide by 2050 will increase by 2,5–3 times [4]. Its deficit will worsen because of a long-predicted, and perhaps inevitable, depletion of natural deposits of hydrocarbons and the urgent need of transition to Green energy. This need is due, among other things, the "greenhouse effect" in the Earth's atmosphere. The cause of such emissions is the traditional "brown" energy. The greenhouse effect has led to global warming of the Planet that is fraught with many troubles for the Earth and earthlings [1, 2, 4, 8, 9, 10, 11].

Even without increasing energy consumption total expenditure on energy will rise as Nature is increasingly struggling to cope with the pressure of it and needs help. To provide modern living standards, mankind will be forced to create new principles of energy supply. For this reason, people thought that there are on our Planet, the rivers and the wild wind, eternal Sunshine, the tide in the seas – oceans (where, incidentally, never calm waves and currents). These and other enduring manifestations of the life-giving natural forces can more than cover the needs of people in energy without disturbing the harmony of Nature [1, 8, 9, 10, 11].

After all, at the dawn of history, mankind did not know about other sources of energy, except those that we call renewable (RES). Technology is evolving in a spiral!?

"*Non-fossil resources*" – that can be called renewable energy. In the world their potential is currently estimated at 20 billion ton. of eq.fuel per year (eq.fuel- equivalent fuel has a calorific value of 29302 kJ/kg). It's 2

times more than can provide the annual production of all fossil fuels. Is that a sign indicating the path of energy development for the future? Traditional fossil energy carriers given to people because of deliberate hard work (sometimes dangerous) and huge capital investments (in terms of energy content 1kJ/kg, they grow rampant). At the same time the atmosphere, the Earth, oceans, space, nature is permeated by fluctuating energy flows. It's ubiquitous. It's hard to find a place on Earth without the presence of any renewable energy [8, 9, 10, 11, 12].

The fundamental qualitative difference between the renewable energy from the traditional energy resources is that renewable energy sources does not increase the entropy of the atmosphere, they are called not-adding, second – adding [1]. Adopting renewable energy resource and using a fraction of it, the man returns to nature in the form of heat. The energy balance is not disturbed. While, when using adding resources, we are faced with the problem of *thermal pollution of the environment* (so often called nature).

Another aspect of the problem: the limit of safe use adds energy should not exceed 0,1 % of the power falling on the Earth from solar radiation is about 100 billion kW. Earthlings generate the same for their needs (urgent or not) 10 billion kWh of this energy. To the critical border is the stock of 90 % [1]. It can quickly melt at the current rate of increase in development adds energy and be exhausted after 60–70 years. The energy of disturbances (in direct and figurative senses) in Nature is already growing and cataclysms will occur more often and more destructively.

Probably, on the Earth in no place without the presence of any RES-resource and they can make a tangible contribution to the formation of the fuel and energy balance (FEB). Their economic development will not only help to optimize the structure of the FEB of these regions, but also to reduce the tension of the transport cargo flows and, accordingly, additional energy saving.

From all that has been said, the *first and main incentive to switch to non-traditional renewable energy sources* is to be ready for the end of the "century of steam" (in fact, it is still going on "in the person of" cyclopic TPPs-the basis of modern power engineering – around of the world).

The second incentive to switch to "green" energy using natural, inexhaustible, renewable energy resources is to prevent an ecological catastrophe and preserve nature for future generations.

According to UNESCO, billions of rural people in the world do not have access to electricity and civilization. This creates great social problems and leads to people leaving for cities, "swelling" of big cities. In Russia, Kazakhstan, a large number of small settlements in rural areas are cut off from power supply systems. There is no energy, no drinking water, low productivity of agricultural production and a low standard of living.

Hence, *the third incentive for the development of green energy based on the use of inexhaustible and renewable energy resources* is the provision of energy for people living in regions remote from existing energy supply systems. The main direction of solving this problem is the creation of decentralized autonomous energy supply systems and individual energy sources, using wind, solar, moving water and other non-traditional renewable energy resources, for example, agricultural waste.

The unit capacity of power plants used here is from 1.0 to 30 ... 50 kW. They are equipped with batteries and provide the work of household energy consumers – communication equipment, televisions, radios, electric lighting, refrigerators, water heaters, air conditioners, water lifts and the like.

To create local energy systems serving settlements, villages, large farms, complex power plants with a capacity of 50–250 kW are used - wind, solar and diesel units. Today's international conflicts are largely wars for energy. The political destabilization of the world is due, as a rule, to the struggle for possession of oil and gas reserves (let us recall "hints" towards Russia about its huge territory and resources).

And so: *the fourth stimulus for the development of energy in alternative and renewable energy sources (ARES)* is the reduction of the level of political intrigues and military actions for the possession of traditional energy resources – oil, natural gas, coal. At the same time, the inexhaustible energy resources of the Wind and the Sun are not subject to monopoly ownership and trade, they are given *equally to everyone*. Competitive struggle in this area goes through the international market of power plants, converters of primary energy into electricity.

In 1978 The UN General Assembly approved a list of non-traditional and renewable energy sources (resolution No. 33/148): solar, wind, geothermal, energy of sea waves, tides and ocean, energy of biomass, shale, tar sandstone and hydro power of large and small watercourses [12].

Over the elapsed time, this list has been significantly enlarged. Given the current reality, it should be expanded and clarified.

The specified list of ARES includes: solar, wind, geothermal energy; energy of sea and ocean currents, waves, tides, temperature gradient of sea water, current and falling water of rivers and canals, low-potential heat of the earth, air, water; biomass energy of animal and vegetable origin, peat, associated gas (often in the development of oil deposits, it is incinerated in flames), solid household and other wastes; New types of liquid and gaseous fuels, represented by synthetic oil based on coal, the organic constituent of oil shale and bituminous rocks (additional hydrocarbon resources), as well as alcohols, fuel for vehicles extracted from biomass, hydrogen and live draft animals. [1, 2, 8, 11].

For a quarter of a century the authoritative international organizations of the United Nations, UNESCO, with the support of the world's leading powers and interested organizations, are carrying out activities on the wide implementation of the technologies of the ARES. Many countries (the USA, Germany, Denmark, Norway, the Netherlands) achieved impressive results.

The trend towards the transfer of energy to the "green rails" was most clearly manifested in recent years in the energy sector of developed countries and regions, especially in North America. There, the shares of renewable resources – hydropower, biomass (including firewood and waste) - equalized and new ways of using such almost traditional resources as wind and sun were equalized. It is also important that the aggregate of renewable resources has reached the share of nuclear energy and, in total, has come close to the share of each of the main fuels [12].

In the scenario of the World Energy Council, an increase in the share of RES utilization to 40 % is envisaged by 2050. The European Union has committed to bring this figure to 20 % by 2020 and up to 30 % by 2040. This is despite the fact that at present non-traditional renewable sources in the world energy consumption structure occupy about 7 %. It is predicted that the leaders in the use of "green" fuel will be the US, Brazil and European countries [4, 12].

The physical nature of each RES has its own [1, 9, 10, 11], methods of their development and application are different. Despite the many difficulties and obstacles in the development of renewable energy technologies in many countries (USA, Japan, Germany etc.) have made significant progress.

Medium-term renewable energy considered not as a replacement of "brown" energy, and as a reserve to address urgent social, economic and

environmental problems [8]. World Energy Council (WEC) considers the likely and possible to increase the share of RES in the energy balance of the Planet by 2050, up to 40 %. Ambitious plans for the development of RES - technologies is the European Union (EU), it is planned to increase the production of energy from renewable energy sources by 2020 to 20 %, by 2030-up to 30 % and by 2050 to 50 % of the total energy needs [1, 4].

We can say that our world is on the eve of the 3rd industrial (energy) revolution (the 1st came in the Age of steam, the 2nd – Age of electricity and the car). Come more "intelligent" and efficient energy. And Era to be called will probably be "the Century of Green energy and digital technology".

Conclusions. The common "definition" of energy as "one of the fundamental properties of matter - its course" actually does not define "what is energy?", in addition, as "it is "a basic property of matter" and the words "...as her movements" don't add clarity;

– reminded and concretized the notion “energy”;

– it is necessary to clearly distinguish forms and types of energy. A form of energy – the essence of the derivative forms of motion (and vice versa) and it is predetermined. In each form of movement will be "its place" for the two types of energy. Their characteristics included in the equations of stationary and transient (mechanical or other) processes;

– types of energy (kinetic, potential) inherent in all of its forms, not just mechanical, as is traditionally considered the default potential energy future work, kinetic - the present work;

– the energy does not disappear (...and there again), it can to dissipate. This process is irreversible;

– within a form of motion energy "flows" from one types to another without intermediate work. Numerical parameters of these processes and ratios depend on the internal characteristics of the system (mechanical, thermal, electrical, etc.);

– mutual transformations of the "work-energy" and "energy work" are the natural state of "tandem" and work is a quantitative measure of qualitative conversion of energy forms and the consequence of it;

– the issue of "birthright" of work or energy, obviously, does not make sense and answer (like the classic "chicken or egg?");

– work because of the interaction between bodies (systems) can affect the parameters of these bodies. People through interaction with nature and practicality can direct these processes in the right, according to technology direction;

– the work cannot "store", but the storing of energy is also possible (examples of this is the Nature) and this is necessary. It is therefore very important to date, the search for substances, environments, tools, technologies, the most suitable for energy storage;

– work inevitably turns into energy. Some forms of energy it is "canned" and when they do occur - a question of time. It may be a moment or an eternity;

– probably "cosmic" forms of energy emerged during the Big Bang. They are released still;

– the conversion of forms of energy takes place through work, mutual transformation of species occurs without the presence thereof. This fact can serve as a criterion to distinguish between form and type of energy;

– can count four stimulus - motive – to change "color" of energy;

– in the antediluvian times (in the literal sense) RES was traditional. In the chronological aspect, the "brown" energy, which is based on the burning of fossil fuels, "reigns" for about 2,5 centuries. It seems that the spiral of energy development is completing the revolution.

– the era of "brown" energy is gradually disappearing, and this young generation will meet the Third industrial revolution. The basis of it will be Green technology, smart solutions and the Internet.

– with the introduction of Green Energy, both "non-energy" and "non-ecological" consequences are possible, as a reduction in the "degree" of international tension.

References

1. Netraditsionnye i vozobnovliaemye istochniki energii: uchebnoe posobie [Alternative and renewable energy sources: the textbook], under the editorship of V.V. Denisova. Rostov/nD: Feniks, 2015, 382 p. (in russian)

2. Da Rosa A.V. Fundamental renewable energy processes. 3rd edition. Moscow: Elsevier: Academic Press, 2012, 908 p.

3. Bystritskii G.F., Gasangadzhiev G.G., Kozhichenkov V.S. Obshchaia energetika (Proizvodstvo teplovoi i elektricheskoi energii): uchebnik [General energy (Production of heat and electric energy): textbook]. Moscow: KNORUS, 2013, 408 p. (in russian)

4. Rodionov V.G. Energetika: problemy nastoiashchego i vozmozhnosti budushchego [Energy: the problems of the present and the possibilities of the future]. Moscow: ENAS, 2010, 352 p. (in russian)

5. Kogan I.Sh. Formy energii i vidy energii i energoobmena [Forms of energy and types of energy and energy exchange], available at: http://www.physicalsystems.org/index03.1.09.html. (in russian)

6. Savel'ev I.V. Kurs obshchei fiziki: vol. 1. Mekhanika. Molekuliarnaia fizika i termodinamika [Course of general physics. – vol. 1. Mechanics. Molecular physics and thermodynamics]. Moscow: Knorus, 2012, 528 p. (in russian)

7. Putilov K.A. Kurs fiziki: uchebnik dlia vuzov [Course of Physics: textbook for high education]. Moskow: OGIZ RSFSR, 1936, 776 p. (in russian)

8. Quashining V. Understanding renewable energy system. 2nd edition. London: Earthscan London, 2016, 406 p.

9. Koishiev T.K. Vozobnovliaemye istochniki energii: Uchebnik [Renewable Energy sources: textbook]. Almaty, 2013, 256 p. (in kazakh)

10. Sorensen B. Renewable Energy Conversion, Transmission and Storage. Moscow: Elsevier: Academic Press, 2007, 344 p.

11. Udalov S.N. Vozobnovliaemye istochniki energii [Renewable energy source]. Novosibirsk: NGU, 2014, 459 p. (in russian)

12. Gorodov R.V., Gubin V.E. Netraditsionnye i vozobnovliaemye istochniki energii [Alternative and renewable energy sources]. Tomsk: Tomskii politekhnicheskii universitet, 2009, 294 p.

Библиографический список

1. Нетрадиционные и возобновляемые источники энергии: учеб. пособие / под ред. В.В. Денисова. – Ростов н/Д: Феникс, 2015. – 82 с.

2. Да Роза А. Основы процессов возобновляемых источников энергии. – М.: Эльзевир: Академич. изд. дом, 2012. – 908 с. (на англ. яз.)

3. Быстрицкий Г.Ф., Гасангаджиев Г.Г., Кожиченков В.С. Общая энергетика (Производство тепловой и электрической энергии): учебник. – М.: КНОРУС, 2013. – 408 с.

4. Родионов В.Г. Энергетика: проблемы настоящего и возможности будущего. – М.: ЭНАС, 2010. – 352 с.

5. Коган И.Ш. Формы энергии и виды энергии и энергообмена. – URL: http://www. physicalsystems.org/index03.1.09.html

6. Савельев И.В. Курс общей физики: в 4 т. Т.1: Механика. Молекулярная физика и термодинамика. – М.: Кнорус, 2012. – 528 с.

7. Путилов К.А. Курс физики: учебник для вузов. – М.: ОГИЗ РСФСР, 1936. – 776 с.

8. Куашнинг Ф.Понимание систем возобновляемых источников энергии. – 2-е изд. – Лондон: Эрфскан, 2016. – 406 с. (на англ. яз.)

9. Койшиев Т.К. Возобновляемые источники энергии: учебник. – Алматы, 2013. – 256 с. (на казах. яз.)

10. Соренсен Б. Преобразование возобновляемой энергии, передача и аккумулирование. – М.: Эльзевир: Академич. изд. дом, 2007. – 344 с. (на англ. яз.)

11. Удалов С.Н. Возобновляемые источники энергии. – Новосибирск: Изд-во НГТУ, 2014. – 459 с.

12. Городов Р.В., Губин В.Е. Нетрадиционные и возобновляемые источники энергии. – Томск: Изд-во Томск. политехн. ун-та, 2009. – 294 с.

Р.С. Сырлыбаев, Г.В. Стульников, А.М. Солтанаев, Т.Н. Агимов

Алматинский университет энергетики и связи, Алматы, Казахстан

ЭНЕРГИЯ И ЭНЕРГЕТИКА. ФЕНОМЕН, ОПРЕДЕЛЕНИЯ, РЕСУРСЫ И ИСТОЧНИКИ, ВЕКТОР РАЗВИТИЯ

На просторах Космоса и в недрах Земли – энергия везде. Её потоки пронизывают пространство. Существование людей, качество жизни, функционирование социума зависят от обеспеченности энергией, богатства страны энергоресурсами. В то же время в научной литературе, учебниках для технических вузов наблюдаются разночтения, путаница в терминах и определениях по этой тематике. Нет даже конкретного определения термина «энергия». На основе анализа предлагаются четкие ясные формулировки. Надо неукоснительно разграничивать понятия «форма энергии» и «вид энергии», их смешивают даже маститые авторы. Форма движения материи определяет форму энергии. Внутри каждой формы энергии (движения) существуют два ее вида. Потенциальная энергия «обещает» работу, кинетическая – в неё превращается. В современном списке форм энергии 14 наименований. Он, наверное, не окончательный. Возможно, существует вакуумная энергия, присущая космическому вакууму, как форме материи. Подчеркивается: нагрузки на природу растут (парниковый эффект, добавляющая энергия). Запасы традиционного топлива истощаются, и все острее, встает вопрос о переходе к «зеленой» энергетике.

Ключевые слова: энергия; формы и виды энергии; условия конвертации энергии; традиционные источники энергии; «зелёная» энергетика.

About the authors

Syrlybaev Rashid Salihovich (Almaty, Republic of Kazakhstan) is a Ph.D. in Technical Sciences, Associate Professor Almaty University of Power Engineering and Telecommunications (AUPET) (050013, Almaty, Baitursynov str., 126, tel. 292-73-73, e-mail: epp@aipet.kz).

Stulnikov Gennadi Victorovich (Almaty, Republic of Kazakhstan) is a Ph.D. in Technical Sciences, Associate Professor Almaty University of Power Engineering and Telecommunications (AUPET) (050013, Almaty, Baitursynov str., 126, tel. 292-73-73, e-mail: epp@aipet.kz).

Soltanayev Abylaikhan Mukhityuli (Almaty, Republic of Kazakhstan) is a Ph.D. student Almaty University of Power Engineering and Telecommunications (AUPET) (050013, Almaty, Baitursynov str., 126, tel. 292-73-73, e-mail: solabuka@mail.ru).

Agimov Talgat Nurlanovich (Almaty, Republic of Kazakhstan) is a Ph.D. student Almaty University of Power Engineering and Telecommunications (AUPET) (050013, Almaty, Baitursynov str., 126, tel. 292-73-73, e-mail: agimov-t@mail.ru).

Сведения об авторах

Сырлыбаев Рашид Салихович (Алматы, Республика Казахстан) – кандидат технических наук, доцент Алматинского университета энергетики и связи (АУЭС) (050013, Алматы, ул. Байтурсынова, 126, тел. 292-73-73, e-mail: epp@aipet.kz).

Стульников Геннадий Викторович (Алматы, Республика Казахстан) – кандидат технических наук, доцент Алматинского университета энергетики и связи (АУЭС) (050013, Алматы, ул. Байтурсынова, 126, тел. 292-73-73, e-mail: epp@aipet.kz).

Солтанаев Абылайхан Мухитұлы (Алматы, Республика Казахстан) – докторант Ph.D. Алматинского университета энергетики и связи (АУЭС) (050013, Алматы, ул. Байтурсынова, 126, тел. 292-73-73, e-mail: solabuka@mail.ru).

Агимов Талгат Нурланович (Алматы, Республика Казахстан) – докторант Ph.D. Алматинского университета энергетики и связи (АУЭС) (050013, Алматы, ул. Байтурсынова, 126, тел. 292-73-73, e-mail: epp@aipet.kz).

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