

Effective Use of Renewable Energy Resources is a Determining Factor of Sustainable Economic Development

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The whole history of mankind is related to development of fuel-energy because deficit and abundance of energy resources significantly determines economic and political development of any country. Global financial, energy and environmental crisis has drastically changed the view about future of fuel-energy development. Civilized world now believes that following 40-50 years we will face absolute exhaustion of resources and there will be difficulties in application of such resources with respect to environment. Therefore, countries are challenged to pursue energy-saving policy, to focus on new renewable energy sources due to lack of fuel resources which may delay efficient consumption of natural fuel-energy resources.

Currently, energy safety and fuel-energy policy represents a significant and critical problem not only for Georgia but for the whole world because demand of states for oil and natural gas is steadily increasing and political leaders of those countries that have no such resources, face a big dilemma on how to meet their state's needs for energy at a reasonable price and to observe sustainable energy safety. Countries that own or have access to large amounts of energy supplies seek to use this advantage as a foreign policy tool.

Keywords: *renewable energy resources, global heating and energy policy, global warming, sustainable economic development.*

Today, the global energy balance is distributed as follows: oil consumption – 36%, natural gas – 28%, coal – 18%, hydro resources – 14%, atomic power – 3% and non-conventional energy resources – 1%. Intensive use of organic fuel resources is exactly the cause of increase in greenhouse effect on the earth and global warming, besides these sources are exhaustible and non-renewable and sooner or later should be replaced with alternative (renewable) resources. Notable is the fact that global annual oil production is 3,4 billion tons while world oil reserve amounts to 140 billion tons. In the long-run, oil prices will significantly rise and there will be a risk of exhaustion of oil reserve, as if consider current production rate, oil reserve will be sufficient for 40-50 years. Production of natural gas is 2-3 trillion m³ and it is estimated that consumption of natural gas will reach its maximum by 2030 suggesting rise in prices and reduction in natural gas reserves.

In modern world, dynamics of development of fuel-energy system and above noted trends point to beginning of a new stage characterized by partial transition from use of conventional organic fuel energy resources (coal, oil, natural gas and others) to use of alternative energy sources. Specifically, in view of meeting increasing demands on energy resources and minimizing dependency on import, renewable, ecologically clean sources play an important role such as: hydro resources, geothermal waters, solar, wind, biomass energy. Adoption of mentioned non-conventional renewable resources and rational use in the near future will significantly enhance fuel-energy complex of any country. Alternative resources differ from organic resources in two important qualities: they are essentially unexhaustible, do not disturb ecological balance and are less harmful to the global environment. Expansion of scales of nontraditional types of energy requires exploration of more effective technical instruments, development of material-technical base and manufacturing of specialized equipment.

Energy resources may be divided in two categories: renewable (alternative) and non-renewable (conventional) resources. The first category includes solar (helio), wind (eolo), geothermal waters, biomass and sea waves. The second category covers conventional energy resources – hydro, fuel and atomic energy. Scientific studies demonstrate that rational adoption and efficient use of renewable resources will notably improve condition of fuel-energy system of any country in the world.

Advantages of renewable energy resources:

- ❖ No adverse impact on environment and ecological balance;
- ❖ Completely renewable and unexhaustible;
- ❖ Use of renewable energy resources and introduction of innovative technologies will reduce emission of harmful hydrocarbons and global greenhouse effect;
- ❖ Each country itself controls and regulates own consumption.

Disadvantages of renewable energy resources:

- ❖ Completely renewable though seasonal. Specifically, during winter, solar energy resources are minimum and disproportionate (at night) and generation of electric power is too small, in summer during droughts potential of hydro-energy potential of rivers (high water level) is reduced and less electric power is generated.
- ❖ Tree cutting, biomass collection, storage and processing is rather costly, besides construction of small, medium and large hydropower stations requires investments and operational expenses.

Georgia is not rich in oil and natural gas deposits but the country has a potential of unique renewable resources like solar, wind, geothermal waters, biomass.

Hydro resources occupy an important place among the natural resources of Georgia. The wide branched river network is combined with the high mountainous terrain and the abundant atmospheric precipitation determines the large supply of water energy. The annual total runoff is 66 km³, which is unevenly distributed throughout the country. Annual runoff of total rivers in western Georgia is 49.7 km³ per year, and the share rivers of eastern Georgia is 16.3 km³ per year.

Georgian rivers are characterized by high hydropower potential. The potential capacity of all rivers in the country is 26.1 million kw which corresponds to 159.4 billion kWh power per year. The largest reservoirs in the country - Enguri, Rioni, Mtkvari, Kodori, Bzipi, Tskhenistskali, Aragvi and Khrami - are used for hydropower purposes from 26,500 rivers. Further exploitation of Georgia's hydropower resources is still inexhaustible, as only 20% of Georgia's hydropower resources are exploited, and the country suffers from a large shortage of fuel, electricity and is mainly dependent on energy imports. Thus, it is extremely important to accelerate the use of the energy potential of the rivers of Georgia, which will naturally benefit both the population and the improvement of the socio-economic problems of the country.

Out of 23 deposits of geothermal waters of our country, 17 are being processed. These are Kindghi-Mokvi, Rechkhi, Saberio, Zugdidi-Tsaishi, Kvaloni, Menji, Samtredia, Vani, Tbilisi, Bichvinti, Kharagauli, Alazani, Kardanakhi, Jandari, Kvareli and Eniseli.

Geothermal waters are used for thermal energy purposes in communal farms, greenhouses, for technological needs in tea industry, at balneological resorts and more. However, the use of thermal waters is highly unsatisfactory. The level of use of geothermal waters does not exceed 30-35% while the forecast stock is 220-250 mln. cubic meters per year. The rest of the water is spilled and causes both thermal and ecological pollution of the nearby area. In case of utilization of geothermal resources in Georgia, it will be possible to save 2.5 million tons of conditional fuel, which has economic and significant environmental effects. It should be noted that geothermal energy is used in energy by more than 20 countries in the world, including Iceland, France, USA, Australia, New Zealand and others. Even in developed countries, the share of geothermal water energy in total

energy is very small, but the prospects for the development of this type of energy are important. The huge reserves of the earth's geothermal waters are almost practically inexhaustible, their thermal potential is determined at 2.94×10^{24} joules.

Currently, geothermal energy is being developed in more than 50 countries. Countries that depend on oil imports have the most success in geothermal energy. For example, the Philippines, El Salvador, Argentina, Ecuador, as well as highly developed countries - the US, Japan, Italy and others. Geothermal water in Georgia can be used for energy, greenhouses, commercial structures and homes for heating and hot water supply through geothermal systems.

Helio resource - the sun is the largest source of energy with a capacity of 4×10^{23} kWh, with about 10^{14} kW capacity on Earth or 34 billion tons of conventional fuel per year. On average 1 kW falls on 1 m^2 of illuminated earth surface.

Using solar energy for heating installations is undoubtedly rational but when it comes to getting electricity - it is still an expensive source, although significant work is being done in developed countries in this regard. Currently, more than 8 million homes in Japan receive solar-heated water, with a total capacity of 3.2 million kW. More than 50 solar power plants with tens of thousands of kilowatts have been built in the USA, France, Spain, Italy and Japan.

In most parts of Georgia, the annual duration of sunshine is quite long and ranges from 200 to 250 days. At the same time, it should be noted that the regions of Eastern Georgia are sunnier than the Black Sea and Kolkhetti lowlands. The highest rate of sunshine during the year is observed in Rodionovka (2633 hours), the lowest in Sairme (1147 hours), in winter months the average sunshine is 80-120 hours (maximum 25-40%), and in summer months sometimes 225-300 hours (50- 65%) and 300-360 hours (70-75%) in favorable years.

Specific indicator of solar energy on 1 sq.m. of the territory of Georgia is theoretically 1500-1800 kWh per year, and the total energy potential for the entire area of the country is estimated at 10 billion kWh. that is equivalent to 34 billion tons of conditional fuel. With the help of solar thermal collectors, use of solar panels can save 7 million tons of conventional fuel equivalent to energy per year, which is almost half of the organic fuel consumed in the country for energy purposes. The maximum effect of the use of solar energy in accordance with natural resources can be obtained in the mountains of southern Georgia and the lowlands of eastern Georgia, as well as in Kolkhetti, the coast of Abkhazia and Adjara.

The main disadvantage of solar energy is its seasonality and unevenness (at night, in cloudy weather, in winter), so it is necessary to create backup units and batteries. Currently, the use of solar energy in Georgia is only in its infancy, but in the future it should become essential.

In the next decade, significant attention should be paid to the inclusion of constantly renewable solar energy in Georgia's fuel and energy balance. Considering the practice and experience of the world's leading countries in terms of solar energy production, solar energy is considered a top priority in the fuel and energy system of Israel, Germany, Italy, Belgium, USA, China.

Use of wind (eolo) energy. There has been a renewed interest in wind energy in the 1970s due to the crisis in world energy, resulting from rising prices for organic fuels, especially oil. During this period, the conditions for maintaining the ecological balance of the environment were also aggravated, emitting large amounts of harmful emissions, which are obtained during the combustion of organic fuels.

Currently, developed capitalist countries have made great achievements in the use of wind energy: Denmark, the Netherlands, France, England, Sweden, China, and the United States. In these countries, wind power plants have been developed and operated in large quantities, at the same time they are being developed, and in some places the introduction (of the USA, Denmark) of the construction of high-capacity wind power units. State programs for the use of wind energy have been developed and implemented in these countries, with the

aim of increasing the share of electricity generated by wind in total demand. Developed capitalist countries aspire to restore their energy balance by 15-20% at the expense of wind energy.

Georgia is a unique country in terms of wind energy use. It possesses significant energy potential of wind energy. In particular, it is possible to generate 4 billion kWh of electricity annually. In our country there are all conditions for the use of wind, which will have a significant impact on the development of the fuel-energy system, as well as in solving environmental and socio-economic problems. Scientific studies show that the theoretical resources of wind energy production on the territory of Georgia can be estimated at 1012 kWh. In fact, the share of wind energy can be 2-3 billion kWh per year. electricity which indicates a promising development of wind energy.

There are rather favorable conditions for the development of wind energy in Georgia: 165 meteorological stations have accumulated vast statistics on wind speeds and directions for decades. Based on these directions, the magnitude of the wind potential is estimated, its spatial distribution is studied, and the country is zoned according to the magnitude of the wind potential, where the magnitude of the wind potential corresponds to the large wind energy requirements. Based on these data, it is permissible to start designing and building a wind plant at several specific locations. In particular, it is the backyard of Mta-Sabuetti meteorological station located on the Likhi range, Poti port mall, the outskirts of Kapandibi meteorological station in Kakhaberi lowland and others.

Due to favorable climate, Georgia has the greatest potential for the creation of biomass power plants, especially for obtaining hot water and heating. Biomass is considered an important source of energy supply in the regions and rural areas. In addition, 40% of the country is covered by forests.

biomass energy Georgia's core biomass energy potential is 12.5 billion kWh. For comparison, it should be noted that the generation by the power system does not exceed 8-10 billion kWh. The use of biomass is currently found in the form of firewood consumption and can even lead to ecological disaster. It is necessary to turn the great potential of biomass into a source of electricity generation in order to clean the country from agriculture and urban waste. At the same time, it should be noted that the country has chosen the development of international tourism as a priority strategic direction, which requires maximum compliance with special aesthetic rules and sanitary regulations.

The efficient use and vast utilization of the above-mentioned renewable (alternative) energy resources - hydro resources, solar, wind, geothermal waters, and biomass resources will contribute to the development of the country's fuel-energy system and reduction of dependence on imports, development of electricity and heat supply for high mountainous resorts and tourist areas, industrial, agricultural and communal farms.

Continuously rising prices of organic fuels – oil, natural gas and electric power, import of such resources from politically unstable countries, deterioration of ecological balance makes more efficient use of energy resources more and more relevant that implies solution of ecological problems of fuel-power complex and possibility of getting cheap electric power. The following should also be considered – monetary and material expenses incurred with regard to transition to a new system of power consumption, organic fuel cutbacks, cost of accompanying precious products, and reduction of losses resulting from environmental pollution.

Conclusion.The current financial, energy and ecological crisis in the world has completely changed the imagination on the future of development of fuel-energy. Civilized humanity has convinced that 4-5 decades later we will deal with the principled resources, and in ecological point of view we will have difficulties in their use. Therefore, it became necessary for countries to implement policy of energy saving, fuel resource depletion makes orientation on new energy repairing sources, the use of which can slow down the inefficient spending of natural energy resources, along with it the energy safety and fuel and energy policy today is the actual and a severe problem for the whole world.

For today the energy balance of the world is allocated as following: 36% - on oil consumption, 28%- on natural gas, 18%- on coal, 14%- on hydro resources, 3% - on nuclear power and 1% - on non-traditional energy resources. The intensive use of organic fuels causes the growth of heat and global warming on The Earth, and these sources belong to the exhaustible and non-renewable category, so soon or later we will have to replace with alternatives (renewable resources). Besides, it should be taken into account that annual oil production in the world is 3.4 billion tones, if we consider that the world's oil reserves are estimated at 140 billion tonnes. In the long-term perspective prices will be sharply rising on oil and the danger will be set on exhausting oil supplies, as oil supplies will be sufficient for 40-50 years in view of modern extraction. Natural gas extraction is 2-3 trillion m³, forecast indicators suggest that the share of natural gas consumption will reach to maximum by 2030, which indicates to the price increase and reduction of natural gas reserves.

The dynamics of the development of the fuel-energy system in the modern world indicates the beginning of a new phase that is characterized by partial transition on the use of renewable sources (alternative) of energy from traditional energy (coal, oil, natural gas and other) consumption.

Renewable resources differ from organic resources in two important features: they are practically inexhaustible, their effective use does not disturb the ecological balance and causes less damage to the global environment, which is an important factor determining a sustainable economy.

The development of a sustainable economy implies a system where the effective use of renewable energy resources and the maximum consideration of the interests of natural environment protection ensure the well-being of society, raising the standard of living, and at the same time do not endanger future generations in the optimal use of limited energy resources and the maintenance of ecological balance on a global scale.

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განახლებადი ენერგეტიკული რესურსების ეფექტიანი გამოყენება მდგრადი ეკონომიკის განვითარების განმსაზღვრელი ფაქტორი

ლალი ხიხაძე

ასოცირებული პროფესორი

ივანე ჯავახიშვილის სახელობის თბილისის სახელმწიფო უნივერსიტეტი

კაცობრიობის განვითარების მთელი ისტორია დაკავშირებულია სათბობ-ენერგეტიკის განვითარებასთან, რადგანაც ენერგეტიკული რესურსების დეფიციტი და სიუხვე მკვეთრად განსაზღვრავს ნებისმიერი ქვეყნის ეკონომიკურ და პოლიტიკურ განვითარების დონეს. მსოფლიოში მიმდინარე ფინანსურმა, ენერგეტიკულმა და ეკოლოგიურმა კრიზისმა სავსებით შეცვალა წარმოდგენა სათბობ-ენერგეტიკის განვითარების მომავალზე.

თანამედროვე მსოფლიოში ცივილიზებული კაცობრიობა დარწმუნდა, რომ 4-5 ათწლეულის შემდეგ საქმე გვექნება პრინციპულად ამოწურულ რესურსებთან, ხოლო ეკოლოგიური თვალსაზრისით სიძნელები გვექნება მათ გამოყენებაში. ამიტომ ქვეყნების წინაშე წარმოიშვა აუცილებლობა ენერგომომჭირნეობის პოლიტიკის განხორციელებისა, სათბობი რესურსების გამოფიტვა ორიენტაციას აკეთებს ენერგიის ახალ აღმდგენად წყაროებზე, რომელთა გამოყენებამაც შეიძლება შეანელოს ბუნებრივი სათბობ-ენერგეტიკული რესურსების ეფექტიანი ხარჯვა.

მსოფლიოს ენერგეტიკული ბალანსი ასეა განაწილებული: ნავთობზე მოდის მოხმარების-36%, ბუნებრივ აირზე-28%, ქვანახშირზე-18%, ჰიდრორესურსებზე-14%, ატომურ ენერგეტიკაზე-3%, ხოლო არატრადიციულ ენერგორესურსებზე მოდის 1%. სწორედ ორგანული სათბობი რესურსების ინტენსიური გამოყენება იწვევს დედამიწაზე სითბური ეფექტის ზრდას და გლობალური დათბობის პროვოცირებას, ამასთან ეს წყაროები ამოწურვად და არაგანახლებად კატეგორიას განეკუთვნება, ამდენად ადრე თუ გვიან მოგვიწევს მათი ჩანაცვლება ალტერნატიული (განახლებადი რესურსებით). ამასთან ერთად გასათვალისწინებელია, რომ ყოველწლიური ნავთობის მოპოვება მსოფლიოში შეადგენს 3,4 მლრდ. ტონას, თუ გავითვალისწინებთ, რომ ნავთობის მსოფლიო მარაგი შეფასებულია 140 მლრდ. ტონად. გრძელვადიან პერსპექტივაში მკვეთრად გაიზრდება ფასები ნავთობზე და საშიშროება იქმნება ნავთობის მარაგის ამოწურვაზე, რადგანაც თანამედროვე მოპოვების თვალსაზრისით ნავთობის მარაგი საკმარისი იქნება 40-50 წლის მანძილზე. ბუნებრივი აირის მოპოვება 2-3 ტრილიონ კუბ.მ. შეადგენს, საპროგნოზო მაჩვენებლებით ნავარაუდევია, რომ ბუნებრივი აირის მოხმარების ხვედრითი წილი 2030 წლისათვის მაქსიმუმს მიაღწევს, რაც მიგვანიშნებს ფასების ზრდაზე და ბუნებრივი აირის მარაგების შემცირებაზე.

თანამედროვე მსოფლიოში სათბობ-ენერგეტიკული სისტემის განვითარების დინამიკა და ზემოთაღნიშნული ტენდენციები მიუთითებს ახალი ეტაპის დასაწყისზე, რომელიც ხასიათდება ნაწილობრივი გადასვლით ტრადიციული ორგანული წარმოშობის სათბობი (ქვანახშირი, ნავთობი, ბუნებრივი აირი და სხვა) ენერგორესურსების მოხმარებიდან ენერგიის განახლებადი წყაროების გამოყენებაზე. კერძოდ, ენერგორესურსებზე მზარდი მოთხოვნილებების დაკმაყოფილებისა და იმპორტზე დამოკიდებულების შემცირების თვალსაზრისით გარკვეული როლი ეკისრება განახლებად, ეკოლოგიურად სუფთა წყაროებს: ჰიდრორესურსებს, გეოთერმული წყლებს, მზის, ქარის, ბიომასის ენერგიას. აღნიშნული არატრადიციული განახლებადი რესურსების ათვისება და მათი რაციონალური გამოყენება ახლო მომავალში მნიშვნელოვნად გააუმჯობესებს ნებისმიერი ქვეყნის

სათბობ-ენერგეტიკის კომპლექსს. განახლებადი რესურსები, ორგანული წარმოშობის რესურსები-საგან, განსხვავდება ორი მნიშვნელოვანი თვისებით: ისინი პრაქტიკულად ამოუწურავია, მათი ეფექტიანი გამოყენება ეკოლოგიურ წონასწორობას არ არღვევს და გლობალურ გარემოს ნაკლებ ზიანს აყენებს, რაც მდგრადი ეკონომიკის განმსაზღვრელი მნიშვნელოვანი ფაქტორია.

მდგრადი ეკონომიკის განვითარებისათვის სისტემას გულისხმობს, როდესაც განახლებადი ენერგეტიკული რესურსების ეფექტიანი გამოყენება და ბუნებრივი გარემოს დაცვის ინტერესების მაქსიმალური გათვალისწინება უზრუნველყოფს საზოგადოების კეთილდღეობას, ცხოვრების დონის ამაღლებასა და ამასთან ერთად საფრთხე არ შეექმნას მომავალ თაობებს შეზღუდული ენერგეტიკული რესურსების ოპტიმალურ გამოყენებაში და მსოფლიო მასშტაბით ეკოლოგიური წონასწორობის შენარჩუნებაში.

საკვანძო სიტყვები: განახლებადი ენერგეტიკული რესურსები, გლობალური სათბობ-ენერგეტიკული პოლიტიკა, გლობალური დათბობა, მდგრადი ეკონომიკური განვითარება.