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Innovative Aspects Of Energy Resources Saving And Energy Efficiency

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Abstract: The global stocks of energy resources are reducing with each year, and their extraction demands more and more investments. The authorities of the developed countries put lots of effort into the energy efficiency technologies development and their implementation into the life of society and business processes. The aim of this article is to consider the strategic prospects of "green" economic development and justify the central place of energy saving and energy efficiency in the system of business priorities for its innovative impact on production development, including the decrease of the final product price. The choice of case study countries – the USA, Canada, the EU, the UK, Japan, China, Korea, Singapore, Hong Kong, Taiwan, and Russia – allowed to present the diversity of approaches to energy efficiency and saving programs within different social and political cultures. The first part of the article is dedicated to the government programs on energy efficiency and energy saving which are used in many world countries in order not only to improve the environmental situation but also to make the enterprises develop their production technologies and use the energy resources rationally. The second part of the article is devoted to the new alternative sources of energy and the technologies that help to reduce energy use in the everyday life. The importance of building close interconnection of state policy for energy efficiency and innovative business development as the source of opportunities for conducting technological modernization of industrial production focused on the use of advanced energy-saving technologies is stressed.

Keywords: energy efficiency, resources, energy saving, green energy, alternative energy, environment.

INTRODUCTION

In the general meaning the energy efficiency is the efficient use of energy resources and it is the answer to the challenges connected with the climate change, economic development and energy security. It is not a secret that the reserves of high-quality fuel in the ground are very limited [1].

Solving the problem of energy saving will allow stretching these reserves for a longer time. In the process of economic development each state faced the problem of inefficient use of energy resources and each country had to solve this problem.
"More opportunities for energy cooperation exist, such as the development of a joint oilfield services market, the creation of financial-industrial groups, and the creation of joint industrial enterprises for the production and transit of energy resources" [2, p. 409].
Still the energy-saving technologies are recognized as a priority in the state domestic policy in many countries. The energy-saving technologies are developed on the basis of innovative solutions. They are technically feasible at the moment and bring economic benefits. These technologies must also be environmentally friendly and do not change the way of society's life in general and the everyday life of each and every person particularly.
In Russia today, there are still no methods of mining from the bottom of the world ocean and transporting resources meeting the ecological requirements and no complete technology for extracting metals of ecology friendly types [3]. The further economic and social development of any country is impossible without a transition to a more efficient model of social production and consumption, rationalizing the use of resources as well as the solution of the ecological problems.
The inefficient resource-use at a time of growing demand is leading to increasing environmental pressure and resources scarcity that will affect Europe and other parts of the world over the next years and decades. "Only 2% of the total fossil resources extracted in the world are used, whereas 98% of them go to waste" [4, p. 930]. Eco-innovation — putting any country on the path to a resource and energy efficient economy — can be seen as a key to enhancing strategic position on world markets of tomorrow [5].

MATERIALS AND METHODS

The primary method of this study is analysis based on data gathered mainly through desktop research of both online and print sources, including official governmental communiques, reports, academic publications, energy databases, and public news outlets.
Reviews of the literature on innovation and energy saving and efficiency product development reveal the approach that has been used by the different countries in this issue.
Case study countries were chosen with the aim of providing as diverse a sample as possible of different approaches to energy efficiency and saving programs provided by the world leading countries with the different social and political cultures.
The work is exploratory in nature, and we have therefore tried to let a picture emerge from the data rather than imposing the definite alternative energy source to use. Our search thus includes any energy-related initiative and existing green energy sources that have found out and are developed in the different countries and are used by different entities.

State Programs As Energy Recourses Saving Motivation For Enterprises And Production

The transition of the world economy to the new sixth technological mode of development has led to the need for generalization and analysis of measures taken at the level of various economic systems to ensure their own competitiveness in the contour of new boundaries of doing business. "Stable progressive advance both of separate regions and countries in general is primarily connected with a necessity of forming modern competitive structure of economics based on high-tech and power-efficient manufactures organized in such a way to minimize and reuse existing waste products" [6, p. 264].
From the very beginning of its existence the sustainable functioning of the energy sector has traditionally been one of the most important factors ensuring economic growth in any country in the world. Bearing in mind the instant innovations in renewables and the pressures to adopt ecological behaviors, organizations are pushed to make changes in the energy management [7, p. 826].
"In the recent decades the governments of many countries have shifted towards climate and energy policy that favors renewable energy sources (RES), implementation of green technologies" [8, p. 591].
According to the data of the International Energy Agency, in 2018 the global energy investments totaled more than USD 1.8 trillion [10]. "Innovative technologies in the energy industry can be divided into two broad categories: energy saving technologies (energy saving building materials, energy saving lamps, intelligent metering systems, etc.) and energy producing technologies (efficient boilers, solar collectors, biofuel equipment, etc.)" [9, p. 1706].
In Russia, there has been a change in the structure of investment demand and supply: declining activity of the American investment funds in the Russian market has led to increased interest from Asian investment players [11].
The strategic interest in this area of science and technology is emphasized by the inclusion of researches related to the creation of solutions in the field of safe, clean and efficient energy as one of the most important priorities of the Eighth Framework Program of the European Union, aimed at the development of scientific research and technology "Horizon 2020".

In order to increase the efficiency of transferring the results of scientific activities in world practice, the mechanism of the so-called technological platforms has become widespread. It was designed to support the formation of new markets for innovative products and technologies. The markets for green energy are enormous. However, political backing and enabling policies is fundamental because there are not only drivers but also barriers in this issue. They are presented in Fig. 1.

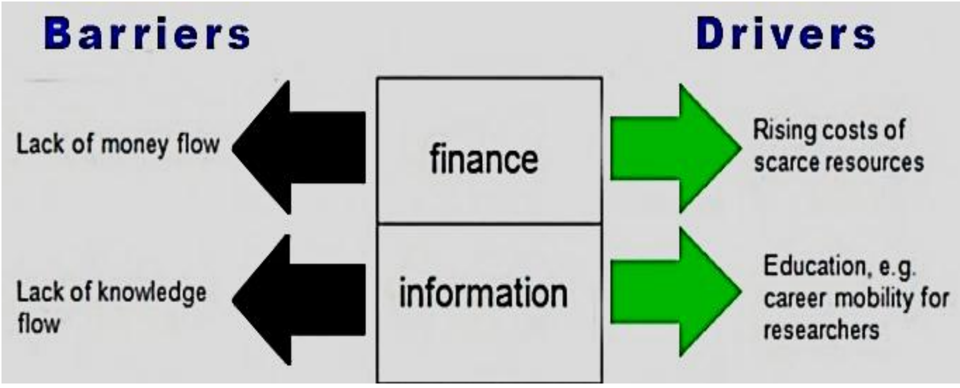

Fig. 1: Drivers and barriers of alternative energy resources development

Government Programs For The Private Enterprises

One of the main reasons of reduction the energy intensity of the economies of developed countries is the widespread use of the opportunities provided by new equipment and new technologies. In its turn, such possibility is provided by the inclusion of energy saving and energy efficiency in the strategic priorities of the scientific and technological development of these countries.

The "Energy Star", voluntary equipment labeling program, launched in the USA and EU countries. It is regularly reviewed in a way that with the adoption of a new standard only about a quarter of the produced equipment corresponds to it. According to this the manufacturers, seeking to remain participants in the program, are forced to improve their products investing heavily in research and development and intensifying their efforts in innovation activity [12].

The following measures can be distinguished among the most important ones adopted in the USA during the last years and aimed at improving energy efficiency [13]:

- the certification program "Superior Energy Performance" that provides the industrial enterprises with technological roadmaps for continuous improvement of energy efficiency while maintaining competitiveness;
- the standards of energy efficiency for the housing sector; the standards of fuel economy for road transport; the discounts for consumers purchasing energy — efficient appliances;
- the grants to states and local governments to support the implementation of energy efficiency and energy saving projects in the real estate that are in their property;
- the targeted investments in energy saving projects and empowering public transport systems;
- increasing energy efficiency of information and communication technologies and increasing the tax breaks for homeowners and enterprises that carry out the modernization of their real estate on their own account aiming to increase energy efficiency and to stimulate of renewable energy generation, etc.

EU adopted the measures aimed at stimulating technological modernization and expanding demand in innovative product markets [14]. The most important among them are the following: the rules establishing minimum standards for energy efficiency of products; the emission standards of CO^2 for the cars and minibuses; the regulatory measures for the EU structural and investment funds; directive of the domestic electricity market, including the measures for the implementation of smart meters and the system of EU emissions trading. The Energy Technology Strategic Plan was revised to stimulate research and development in the field of energy saving and energy efficiency in 2013 [15].

The steps to gradually reduce the dominant position in the market of large electricity companies have been taken in some European countries (the UK, Italy) and in the USA recently. To do it some new energy producing companies are gradually getting involved on the energy market. These companies use innovation energy technologies [16].

In Japan the most important state policy measure in the field of energy efficiency is the support system for business companies in the implementation of innovative energy-saving technologies and concessional lending to energy-saving measures by the Japan Development Bank [17].

There are legislatively fixed criteria for business companies obliged to rationally use energy in production and also there is a guidance on the preparation of long-term plans for various industries regarding electricity, gas,

heat and industrial waste. The tax system is constantly evolving and new mechanisms are introduced to encourage investment in the reorganization of the energy supply system. A support system for business companies has been created during introduction innovative energy-saving technologies [18].
Besides it, the measures for technological development are identified in this issue, including the research of basic technologies for rational use of energy and development of methods for their practical application [19].
The legislative restriction on the use of certain types of obsolete technologies is widespread in the industrial countries of Asia (China, Korea, Singapore, Hong Kong and Taiwan) [20, 21]. For example, a program to close small plants and obsolete facilities was adopted in China ("CSPOC"). At the same time, a ban on obsolete technologies is usually accompanied by stimulation of the diffusion of new technologies including support for enterprises that are developing new products, transfer and localization of innovative technologies of foreign companies, as well as budget subsidies to consumers of these products [22].
In the EU, USA and Japan, government support for innovation is based on the principle of complementarity, the essence of which is to finance work aimed at ensuring the continuity of the country's technological development.
In Canada, Great Britain, Germany and a number of other European countries, active grant support is provided for innovative cooperation between industry and the scientific and technical sphere; financial support for projects from the federal budget is carried out as part of targeted programs.

Alternative Energy Resources
The concept of energy conservation relates to avoiding or reducing the use of energy in various situations. The concept of energy efficiency relates to the minimization of energy input in the processes of delivering a particular type of service. To achieve higher energy savings, both energy efficiency and conserving energy are relevant [23].

Smart House Technologies
The technologies of the smart houses for population and commercial buildings can improve building operations and help to save energy resources [24] (Table 1).

Table 1: Smart house technologies for energy saving

System	Energy saving
Smart heating, ventilation, and air conditioning (HVAC) systems use multiple sensors for monitoring and control.	15–50% of pump or motor energy
Smart lighting consists of advanced controls that incorporate daylighting and advanced occupancy and dimming functions to eliminate overlit spaces.	Up to 45%
Plug loads of different types	From 25% up to 60%
Smart window systems manage the amount of solar heat and daylight that enters the building.	From 20% up to 43%

Source: [25].

The automatic temperature control system of home heating appliances is a good attempt to save energy, but it has its significant drawbacks. Such a system can lead to planned savings only if the houses are well insulated [26]. Therefore, one of the main areas of energy conservation is the high-quality thermal insulation of residential premises, which really allows saving electric and thermal energy.
Besides it, "creation of the technological basis for the development of the innovative infrastructure providing the diagnostics and monitoring of life support systems, the state of household appliances, and housing and communal service devices is becoming a highly relevant problem" [27, p. 1975-1976]. The monitoring of life support systems will provide the control and finding out the problem with the energy supplying [28].

Solar Energy
Another, very effective way of saving electric and thermal energy is the use of solar panels, which is widely used in European countries with a large number of sunny days per year. The basis of the work of solar panels is solar energy, which the sun's rays give. One square meter of the Sun emits 62,900 kW of energy. This roughly corresponds to the power output of 1 million electric lamps. The sun gives the Earth every second 80 thousand billion kW that is several times more than all the power plants in the world.
Solar panels are used on modern Toyota Prius cars. The solar panels located on the roof of the car perform the following function: when the fuel runs out suddenly, due to the battery, the car can travel about 1.5 km.
Solar panels are used in residential buildings. Roofs of houses are covered with solar panels that generate electricity for lighting, household appliances and water heating. Solar panels are also used to power the entire settlements. For example, a power plant located in Spain is equipped with solar panels and mirrors directed at

them that reflect and focus light. About 10 thousand nearby households are supplied with electricity. Solar panels are one of the main ways to get energy on spacecraft. In the process, they do not consume materials and are environmentally friendly.

Water and Wind Energy

Only the settlements located on the shores of the seas and oceans can receive the energy of the tides. That is why such energy supply is impossible for people living in the center of the continents, far from water sources. On the other hand, "appropriation of water by public and private enterprises in order to produce energy may threaten the process of universalization of access to water" [29, p. 440]. To some extend it also may influence badly upon the economy of the country or community located next to the rivers, seas and oceans making shipping difficult [30].

The wind energy is more affordable, which is used in areas with a small number of sunny days per year, where the use of solar panels has low efficiency. Wind energy, being a derivative of the sun's energy, is generated due to uneven heating of the Earth's surface. For many millennia, humanity has been using wind power that is environmentally friendly with no air emissions and hazardous radioactive waste. The wind, as the primary source of energy, costs nothing and can be used decentralized. There is no need to create such infrastructures as, for example, in the production and transmission of electricity generated by burning oil or natural gas.

Wind power plants convert kinetic wind energy into electrical energy using a generator. The blades of windmills are used like an airplane propeller to rotate a central hub connected via a gearbox to an electric generator. The greatest wind potential is observed on sea coasts, on hills and in mountains. Nevertheless, there are many other territories with wind potential sufficient for its use in wind energy. As a source of energy, the wind is less predictable unlike, for example, the sun, however, during certain periods of time, the presence of wind is observed for 24 hours. The advantage of wind power plants over solar panels is that they work around the clock in any weather under the open sky. At present, high-performance wind turbines have been created and they can generate electricity even with very low winds.

Other Sources of Energy

Solar, water and wind sources of energy have been known for centuries but nowadays the scientists and researchers try to create and develop the other alternative sources of energy that will be able to substitute nuclear power and the one produced from gas and oil. "At present time the energy potential of landfill gas (biogas) as an alternative source of energy and, simultaneously, as an element of natural capital is not reflected in the accounting system of organizations" [31, p. 212].

One of the main criteria is that the new energy sources should be environment friendly. "It is commonly known that unified subjects that supply, process and realize biomass resources could become more competitive compared to the business units that use fossil fuels" [32, p. 1457]. The production of energy from biomass can be comparable with the other green energy sources such as wind power and solar plants [33].

Each alternative mean of energy has its cons and pros that should be studied thoroughly before putting them into life. They are presented in the Table 2 below.

Table 2: Advantages and disadvantages of the alternative energy sources

Type of energy source	Advantages	Disadvantages
Solar energy	It is possible to use it not only for producing the energy for houses supplement but also in the car and space industry.	It can be used only during the sunny day period or on the territories with high solar activity.
Wind energy	There is no need to create huge infrastructure. It can be used 24 hours.	It can be used only at the places with high wind activity.
Water energy	It is green energy source. It uses the power of natural phenomena that can be predicted.	It may prevent ship transportation and reduce the economy. It cannot be used on the territories that are located far from the sea, ocean and big rivers.
Biogas	It helps to use the waste.	The negative influence upon environment has not studied yet.

CONCLUSION

As a result of the analysis of the world's leading public administration practices it was found that state policy in the field of energy conservation and energy efficiency was integrated into the country's strategic priorities and formed an order to create modern innovative technologies and equipment in the national economy. Moreover, energy saving and energy efficiency as the most important area of priority technological development of the economy sets an additional vector for the implementation of scientific, technical and development projects to improve machinery, equipment and technologies.

The interconnection of state policy in the areas of energy efficiency and innovative development is becoming increasingly close and creates wide opportunities for conducting technological modernization of industrial production with its focus on the use of advanced energy-saving technologies. In the other words, countries that pursue active policies in the field of energy conservation and energy efficiency consider the stimulation of innovative processes as one of the most important areas of the implementation of this policy that is associated with the use of new technologies and scientific discoveries in the energy sector.

The possibilities of wide energy saving in the form of using solar panels, wind power plants, and ebb and flow plants take place in our everyday life. The greater application and even a massive transition to the use of alternative energy resources is now becoming increasingly relevant and necessary especially considering that the amount of fossil fuel and energy resources is limited and decreases every year.

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