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Innovative development of power engineering enterprises on the grounds of foresight based on innovations in the energy sector within the sustainable development coordinates

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Introduction

Implementation of innovative ideas is an essential tool for the development of both economies of individual countries and the global economy in general. Commercial part of the innovation implementation process is always time-consuming and requires significant attention of researchers and manufacturers. In addition, the process of commercialization involves stages of life cycle specific to the time of goods or services disposal, and the stages of operation, service, utilization. This is why the commercialization of innovation is important both in terms of science and entrepreneurship activities.

A relatively new research tools for system processes in global economy of knowledge are techniques combined by the concept of sustainable development, sustainable production, etc. The implementation of the tested techniques in terms of existing problems of entrepreneurship in the field of innovation allows to identify

certain patterns in the relationship between individual components of new technologies development and prediction of their development, particularly in energy sector, particularly, for power engineering enterprises.

1. Problem definition

Complex, multidisciplinary research studies are the integral part of scientific activities. Methodologies and tools make it possible to identify patterns and offer the results of these studies, however, the practical realization of these developments creates a significant problem. Adoption and implementation of management decisions at the regional (specific country) and global levels for comprehensive areas, in this case innovative energy area, is quite challenging.

2. Review of recent research and publications

Over the last 10 years energy sector has gained much attention among scientists considering the exhaustibility of fossil energy resources. The energy consumption is constantly increasing, making the problem of energy supply even more acute. Integration processes, being the vector of the 21st century, cover the majority of activities, including energy sector. For example, this paper [1, 15-16] reviews the European vector in the development of Ukraine's energy sector from the perspective of European integration. In addition, researchers tend to pay much attention to non-traditional, renewable energy sources [2]. Special attention should be paid to the research work [3], which describes a model "person-housing-environment" from the point of ecological compatibility and residential energy efficiency that is closely connected with sustainable development and innovations.

¹ Energy of Ukraine on the path to European integration: monograph / Edited by A. I. Shevtsova. - Dnipropetrovsk: National Institute for Strategic Studies, 2004. - 148 p.

² Renewable energy in decentralized electricity: monograph / B. V. Lukutin, O. A. Surzhikova, E. B. Shanarova. - M.: Energoatomizdat, 2008. - 231 p.

³ Mhitaryan N. M. Energy and comfort: monograph // N. M. Mhitaryan // Institute for Renewable Energy. - Kyiv: Naukova dumka, 2011. - 439 p.

3. Research Methodology

Methodology is based on scientific research conducted by group of authors who perform systematic research over a long period of time [4] which is based on the Index of sustainable development, supplied by a quaternion, which in turn contains a scalar quantity that describes the security of life and the real scalar part as a projection of the radius vector norm to ideal vector of coordinates (1, 1, 1). This research is based on the individual approaches and elements of this methodology and development [5] and it uses the database of World Data Center for Geoinformatics and Sustainable Development [6].

With the reference to statistically reliable numbers, implementation of data and techniques provided by authoritative organizations makes possible to develop and test some derived techniques that are no longer connected to certain spheres of human activity in general (economic, environmental, social), but only deal with individual components, in our case – the energy component.

4. Definition of work objectives

The main objective of this research is to implement in-depth theoretical and methodical scientific investigation in areas directly related to innovations, including the energy sector, using the conceptual fundamentals of sustainable development and actual calculation of indices and indicators that are closely connected with this concept. In this regard, there is a number of tasks that should be solved in order to fulfill this goal.

⁴ Sustainable development analysis – global and regional contexts / A. Akimova, A. Boldak, S. Voitko, O. Gavrysh etc. // International Council for Science (ICSU) [scientific adviser M. Zgurovskyj]. – Kyiv: NTUU “KPI”, 2010. – P. 1. Global analysis of quality and security of life. – 252 p.

⁵ Voytko S. V. European Union and Ukraine: the Present and Dynamics of indicators for sustainable development / S. V. Voitko // Knowledge Society : A publication of the Knowledge Society Institute. – Sofia, 2013. – Vol. 6. № 3. – P. 18 – 23.

⁶ Official site of World Data Center for Geoinformatics and Sustainable Development [electronic resource] - Access mode: <http://wdc.org.ua/uk/data>

5. Main research material

It is suggested to analyze the relations between indices of economic growth and sustainable development according to 2013 available figures, with special attention being focused on the countries of European Union.

Fig. 1 shows the visualization of relations between Indices of economic dimension and sustainable development for 116 countries, with data available in [7]. Due to the fact, that data provided is used in the methodology of sustainable development, the research is directly related to all components of this methodology. EU countries are outlined separately. For convenience of analysis the entire data set is divided into 16 rectangular areas, restricted by minimal (lines a and A, vertically and horizontally respectively) and maximum values (e and E horizontally) for each Index. Lines (c and C) divide the area vertically and horizontally. They are located in such a way that between the maximum and minimum for each index and these lines is located the half of the points, that characterize the position of countries according to these indices. Lines d and D, as well as b and B are formed by dividing into half the following zones: a-c, A-C, c-e and C-E.

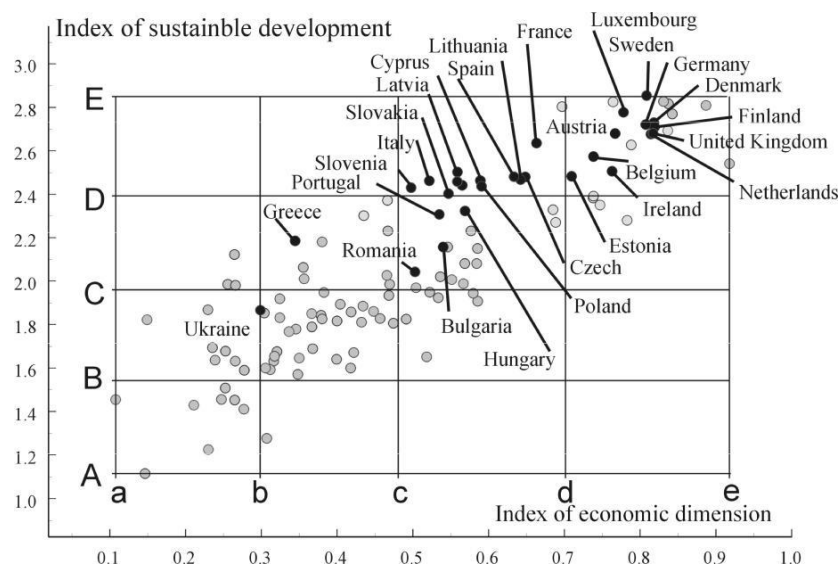


Figure 1. Zoning in countries location within coordinates of Index of sustainable development and Index of economic dimension

⁷ Official site of World Data Center for Geoinformatics and Sustainable Development [electronic resource] - Access mode: <http://wdc.org.ua/uk/data>

The results of such zoning analysis show the following situation. According to the Index of economic dimension Ukraine and Greece are included into the second half of countries. According to the Index of sustainable development only Ukraine is located in the A-C zone. The fact that Greece belongs to C-D-b-c zone can be explained by strong impact of the global economic crisis. The majority of EU countries are located in rectangle limited by lines D-E-c-e, which shows rather high value of Index of sustainable development and better economic development comparing to other countries. Special attention of European Union should be paid to such countries as Greece, Bulgaria, Hungary and Portugal.

Fig. 2 shows the relation of economic and environmental dimensions, that are components of Index of sustainable development. Countries that mostly use renewable energy are chosen.

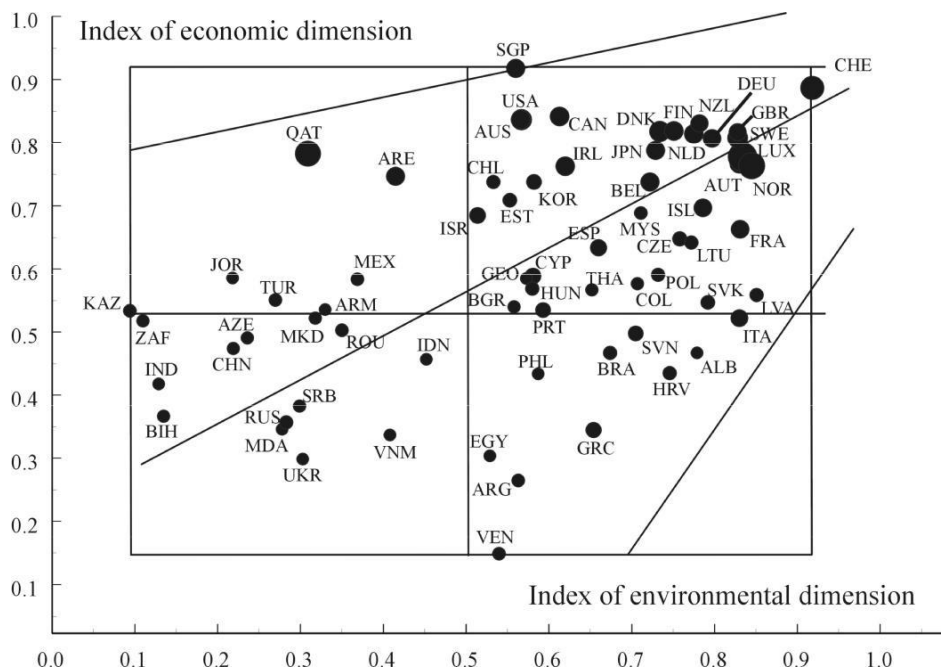


Figure 2. Visualization of relation between economic and environmental dimensions

It should be noted that according to indices of economic and environmental dimensions countries are rather spread on the plane. The lines specify the following: the middle line divides the area into equal parts in the direction of the trend; the upper line

limits the top maximum point with regard to the density of points and trend line; the bottom line is reflecting the upper line. However, there is some congestion in the upper right zone. Here most countries are quite developed. Besides, certain concentration of countries in the upper right zone of the coordinate system is specific. Duly confirmed is the fact that industrialized countries are significantly losing their positions in environmental dimension because of ecologically harmful manufactures located there. This is proved by the middle position of the U.S.A. in the ranking list according to Index of ecological dimension. The majority of EU countries is located in a favorable zone: significant value of Index of economic dimension and high value of Index of ecological dimension. Note: values of these two indices are not sufficiently high for Ukraine.

Analyzing each rectangle formed by minimum and maximum values and the midlines within corresponding coordinates, we should note the following:

- 1) the majority of countries is grouped in the upper right rectangle (high indices values of environmental and economic dimension);
- 2) the minority of countries is located in the upper left rectangle, that shows some imbalance between high economic development and low values of environmental component;
- 3) the main diagonal is outlined, which reflects the balance between economic and environmental development of countries and runs from the lower left to the upper right rectangles;
- 4) Generally, EU countries are located at a considerable distance from the main diagonal;
- 5) Ukraine has slightly better values of environmental component, rather than of economic one;

Ecological situation of any country to some extent depends on implementation of advanced technologies of renewable, alternative energy. In Fig. 3 the circle area shows the visualization of these technologies within the coordinates of energy security and sustainable development indices. Data is taken from the official site [8].

⁸ Official site of World Data Center for Geoinformatics and Sustainable Development [electronic resource] - Access mode: <http://wdc.org.ua/uk/data>

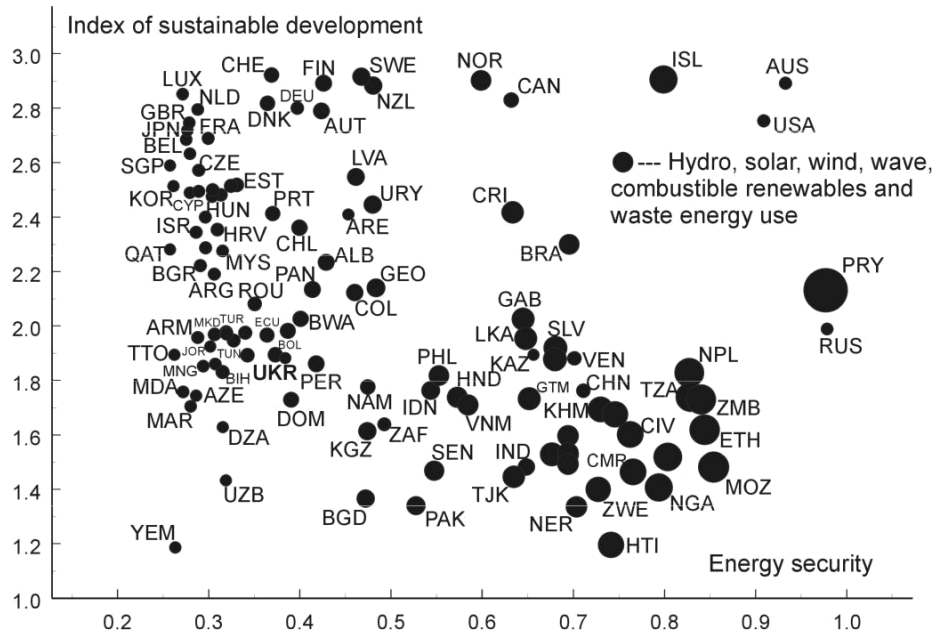


Figure 3. Location of countries within coordinates of energy security and sustainable development indices

Analyzing the location of countries within coordinates of economic security and sustainable development, the attention should be paid to the fact that the majority of countries with low level of alternative energy sources consumption are found in the zone of low energy security, and countries with high and relatively high levels are characterized by moderate level of index values in sustainable development and a high level of energy security. Note that EU countries are not found in this zone.

Fig. 4 shows the dependence of energy security on Index of economic dimension, circle area reflects the intensity of alternative energy sources consumption.

the analysis in addition to the topics of this study clearly identifies countries that suffered greatly from the effects of global economic crisis. We should particularly note the collective approach of EU countries towards solving social, economic, and particularly energy issues, that are common for this regional association. Note scattered location of countries within coordinates for indices of economic and environmental dimensions of sustainable development.

In addition, we should pay attention to the fact that the charts given and specifically the location of points representing the specific country demonstrate that sufficiently high levels of economic development and stability are provided as well by using traditional fossil energy sources, and not alternative, renewable, which requires further research.

Therefore, in order to intensify the innovation process in industrial energy sector and to build scenarios of innovative development for power engineering enterprises, the results of indices analysis are provided, which are fundamental for sustainable development methodology. This may be due to the fact that globally it is a good practice to consider achievements of scientists in the fields of ecology, economy and social development in the framework of conceptual foresight (by trends) and forecasting (including abrupt changes) of power industry enterprises. This is a particularly urgent matter for power engineering enterprises, as their production forms the future of the country power industry. Therefore, it is expedient to build scenarios for the future development of this field, considering innovative approaches on the basis of sustainable development.

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[6, 7, 8] Official site of World Data Center for Geoinformatics and Sustainable Development [electronic resource] - Access mode: <http://wdc.org.ua/uk/data>

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Abstract

The relations between Indices of economic growth and sustainable development were analyzed. The zones within coordinates of Indices of economic dimension and sustainable development were characterized. The correlation between countries in economic and environmental dimensions was considered. Common factors in countries zoning and location within coordinates of these indices were outlined. The characteristic of EU countries grouping in solving social, economic and energy issues was presented, particularly, for power engineering enterprises.

Keywords

Innovation, energy, environment, sustainable development, the European Union, engineering, enterprise, foresight.