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ENVIRONMENTAL AND ENERGY SECURITY COMPONENT OF INTERNATIONAL ECONOMIC RELATIONS

The paper presents a research of the critical infrastructure security, first of all – in the water sector, which affects the state of many industries, in particular – agriculture. The prerogatives of food security in developing countries are explored. The research of one of the most important critical infrastructure branches – energy sector, is proposed. The analysis of energy efficiency in Ukraine is introduced. For this, the energy intensity indicator, the use of a gas / price efficiency indicator, the Herfindahl-Hirshman index were used.

Keywords*:* security; critical infrastructure; food security; energy efficiency; Herfindahl-Hirschman index.

Introduction

The concept of critical infrastructure is sufficiently new. In any society one can identify the networks, sectors, systems that are vital for a society, the withdrawal of which can lead to irreversibly negative public standing, or the cessation of the existence of entire social groups. This can happen locally, nationally, internationally, depending on the type of system. The complex of these components is called critical infrastructure.

Initially, the concept of critical infrastructure has emerged in European and American business and academic communities. This problem has been started to be developed since 1998 due to the increase of terrorist attacks in developed countries. Moreover, the terrorists were not limited to cybernetic infrastructure. Attacks were equally aimed at other vital economic and socially important sectors of the countries.

According to the Presidential Decision Decision 63, the critical infrastructure was defined as follows: «Critical infrastructures are those physical and cyber-based systems essential to the minimum operations of the economy and government. They include, but are not limited to, telecommunications, energy, banking and finance, transportation, water systems and emergency services, both governmental and private» [8].

Materials and methods

The methodological basis of presented scientific research is built on theories, concepts and methods of economic development of the critical infrastructure. The testimony of results is obtained by handling of the certain volume of statistical information using scientifically justified methods of economic research (analysis and synthesis – while investigating enterprises of critical infrastructure, method with application of energy intensity factor – to determine the energy efficiency of the country's economy, method of coefficient of fuel efficiency / price, method of the calculation index of concentration in the markets – Herfindahl-Hirschman index – to determine the degree of the energy market monopolization.

Findings and discussion

The evolution of the model of water use for humanity is to recognize water as a powerful economic production factor. Since ancient times, water is used as part of the production system for growing crops on irrigated lands, along with irrigation infrastructure, land and irrigation and agricultural equipment. The amount of water consumed varies in agriculture, depending on the type of plant. Each of the following factors has its own performance parameters, but the main limiting resource, which mainly determines the yield, is water.

The shortage of water resources in a particular region affects the following factors of its development:

1. restrictions on farming;
2. the formation of a certain structure of industrial production, which depends on the capacity of technology;
3. increase of efficiency of water use and water supply services at the municipal level. Such a factor can be determined by the implementation of the population and organizations of measuring devices, meters and advanced methods of saving.

The sectors of the national economy that use water through water distribution networks are divided into industrial water intensive industries and industries that use flexible water resources (mainly services and households). In most cases, water resources are supplied to them through municipal networks.

For industrial sectors, the use of water resources is taken into account as incomings from the production sector of water supply and includes processing and transportation costs. Such basic approaches form a water management model that takes into account the division between industrial water supply and water supply to the consumption sector, taking into account the low degree of substitution between them. The basic model of water supply is presented in Figure.

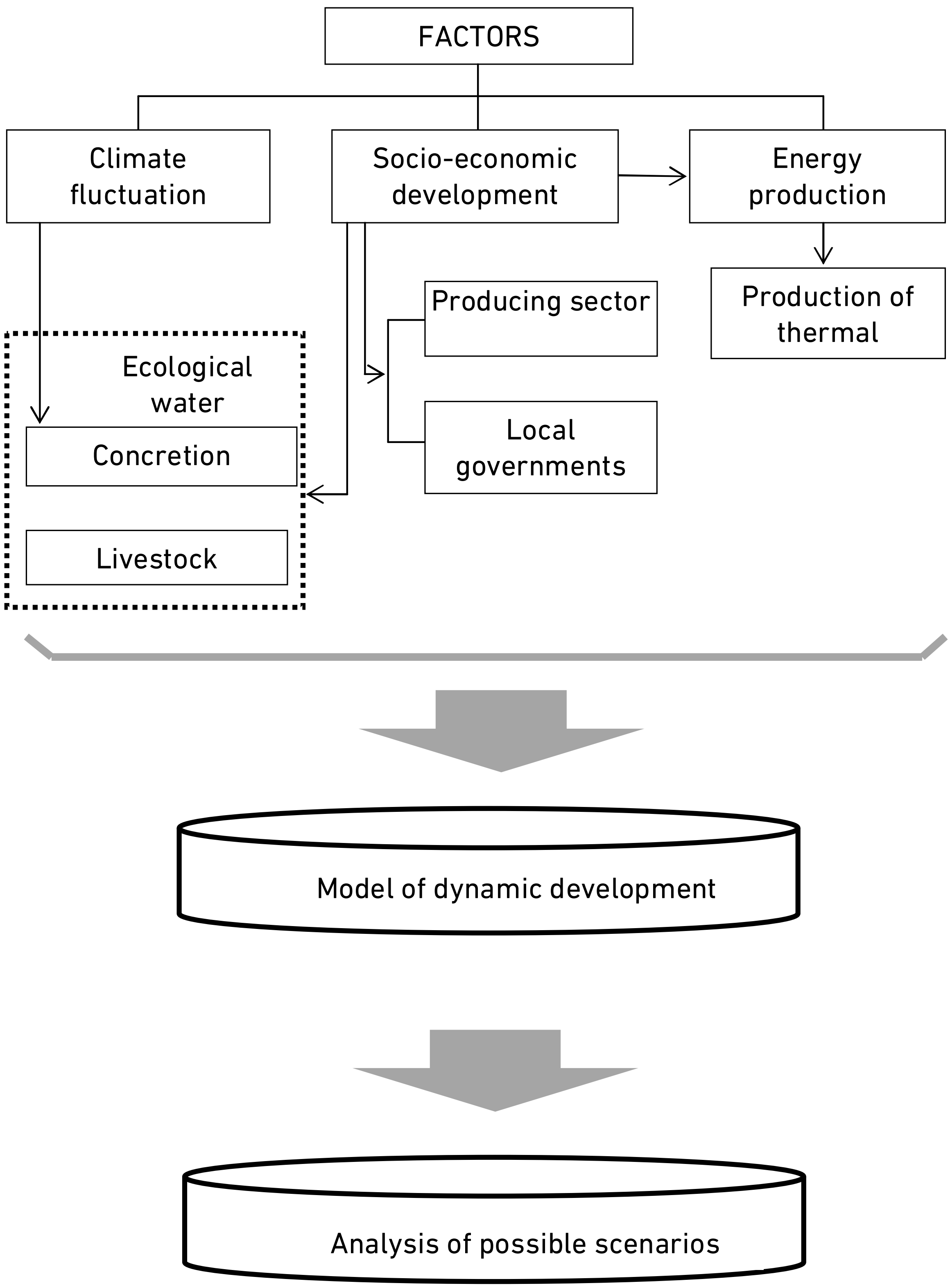

Figure. The basic model of water supply [7]

The first factor in the constructed water supply model is the climate change factor, based on which future harvest results are modeled. The factor of socio-economic development consists of the size of the gross national product, investments in the country's development, trade relations with other countries, coefficients of scientific and technological development, development of transport, infrastructure, population. An important factor is energy production, which is based on the use of water resources in the work of hydroelectric plants, geothermal installations, etc. Socio-economic indicators affect the state of the production sector, local governments, which supply heat to homes and industrial facilities. Energy production affects people's living conditions, production conditions and production technology.

Research on climate change is an important area in the process of forecasting the required amount of water resources for irrigation works to prevent the reduction of crop during drought. This factor also affects the livestock population and the efficiency of livestock farming in agriculture. Due to the changing weather conditions, you need to take care of the cattle with the use of the required amount of water to be drunk by the cattle to prevent diseases. Irrigated agriculture and proper livestock should be accompanied by compliance with the rules for the conservation of the global innovation ecosystem.

Food security is a significant place in the economy of many countries as a component of the development of critical infrastructure and the consequence of such development. This aspect is particularly relevant for the Economic Community of West African States [1].

While developing countries and the world have made significant progress in reducing poverty, in Africa, the percentage of people living in poverty has increased. This process of divergence of countries in terms of food security increased sharply when economic structural transformations took place on other continents. In this way, poverty and food security in Africa are a major economic growth challenge for many countries. The pace of economic growth in African countries has always been too low to catch up with other countries in the world.

The process of regional integration, expanding market size, stimulates efficient resource allocation, increases human capital and labor mobility, develops research in agriculture, diversifies production, improves the production sector, increases domestic savings and investments, improves infrastructure and reduces the need for external debt.

Regional integration through its impact on agriculture, food prices and macroeconomic policies affects food security. The Food and Agriculture Organization (FAO) states that food security will depend on international trade in general and trade in, in particular, agricultural products. Given the ability of intra-regional trade to promote economic growth and increase prospects for employment and income opportunities for the poor, it will increase access to food. Increased intra-regional agricultural trade can also contribute to food security by increasing domestic food supplies to meet the needs of consumption and reduce overall variability of food. In particular, macroeconomic policy plays an important role in the direct or indirect impact on food security, affecting the poverty, food, prices, foreign currency, employment and wages.

Poverty reduction in countries requires increased food availability at the national level and at the level of households. Integration is the best instrument for addressing food security through the integration of trade and markets, investment in agricultural resources, investment in agricultural and trade infrastructure, improving agricultural technologies, reducing domestic and external political pressures, and saving economies of scale. Integration significantly affects the productivity of the agricultural sector by stabilizing food prices, strengthening the regional market and reducing dependence on the international market, improving the quality and structure of exports, and reducing imports. It affects the distribution of countries' revenues, rural development, job creation and competitiveness of the economy, as well as the development of technologies that provide the opportunity to confront bad harvests or natural disasters. Consequently, all these channels of struggle against malnutrition and hunger create a favorable environment for increasing consumption and improving the well-being of the population, which directly affects the level of poverty. The impact of regional integration on food security goes beyond the food and agriculture dimensions and encompasses general economic development indicators that have different implications for the country's trade policy.

Regional integration, identified through direct and indirect channels, affects food security. Food security can be affected by the growth of national income and employment. It is widely acknowledged that economic growth is a necessary step for a sustainable reduction of poverty and food security, even if it may be not fast enough to achieve food security in the short-term perspective. Economic growth increases incomes and the ability of the poor to gain access to food and health and can lead to improved food security.

The energy economy plays a leading role among the components of critical infrastructure. Other components are dependent on the state of this industry. All sectors of the national economy, including communications and information technologies, are energy-dependent. The banking and financial sector, and the health sector are consuming energy on a large scale. There is a need for sustained support in the working environment of the water sector, transport, agriculture, public administration, sanitation, education and science, public order and security, justice and legislation, public services, the chemical industry, postal services and other critical infrastructure components. and reliable power supply. Therefore, it is necessary to analyze this industry in more detail. We have reviewed the main trends in electricity supply in China, a dynamically developing country.

In China, the optimization of the energy system operation on a national scale is becoming increasingly important. China's national network has three levels of control centers – national, regional and provincial. Due to the large size of energy connections at the highest level, it is very difficult to develop methods or algorithms in a centralized manner for the following reasons:

1. at first, the computational complexity will increase significantly due to the increase in the size and volume of the calculations;
2. secondly, the high requirements for communication between layers are unattainable;
3. thirdly, each region in the lowest layer has its own characteristics that may require a certain degree of labor-intensive work, and centralized optimization of this will not allow.

In the case of the Chinese power system, a practical method is being developed that is used in ultrahigh, multilayer systems and allows them to benefit from optimization in a larger area, while computing and communication loads are acceptable. The problem is solved for a multilevel system. We call them national, regional and provincial levels respectively. The main points of this method are as follows:

1. The method is based on three-tier architecture. There is a closed loop between adjacent levels, designed to achieve decomposition with acceptable accuracy;
2. The information exchange between adjacent levels is achieved with the help of the proposed new concept, called the PRF. The PRF contains information on the relationship between the power of the communication line and the LMP on the line of the binding in the corresponding lower level. Using PRF, optimization in the corresponding top layer will be more accurate. The PRF is accounted for dynamically throughout the iterative process.
3. When optimizing SCED in the corresponding upper level, the Ward-network is used, based on the principle of reducing the equivalence for compression of the network information in the corresponding lower level. This significantly reduces the computational complexity.

The procedure of this method is as follows. The internal cycle is intended for coordination between the regional level and the provincial level, while the external cycle is intended for coordination between the national level and the regional level

The main procedures of the internal cycle are the following:

Step 1. Reducing networks. Next, equivalent networks are obtained for each region and for the national level.

Step 2. Each province optimizes its SCED.

Step 3. Using provincial SCED solutions, each province calculates the equivalent injection of net power.

Step 4. Using a SCED based model, each region optimizes its power.

Thus, the proposed method expands the national level of the fully centralized SCED model into three levels [4].

One of the main synthetic indicators characterizing the state's economy is the energy intensity, which is calculated as the amount of consumed energy divided by the country's GDP. We can distinguish between direct and cumulative energy consumption. The first concerns the consumption of energy that is directly consumed in production processes. Cumulative consumption covers the total amount of primary energy used in all processes leading to the production of goods and services. The less energy needed to generate a country's GDP, the easier it will be to ensure energy security in a particular country or economy [3].

Therefore, it can be assumed that the indicator indicates an increase in energy efficiency of energy efficiency if it shows a tendency to decrease, which means a lower price or a lower cost of converting energy into GDP. On the contrary, high and / or higher energy consumption will indicate a high price or energy conversion costs to GDP. The energy intensity index for Ukraine is calculated on the basis of tables 3 and 4 as:

$$e = \frac{E}{GDP}, \tag{1}$$

де *e* – energy intensity of GDP of the country,

E – energy consumption in the country,

GDP – GDP of the country for a certain period of time.

Let's review energy consumption in Ukraine from 2007 to 2017 (Table 1) and energy intensity by years (Table 2).

You can see that the energy consumption of final consumption decreases significantly from 0.217 to 0.149, which means that Ukraine has started to save energy, and this is due to the technological efficiency of energy use. Energy intensity of the total supply of primary energy is also decreasing – from 0.3562 to 0.267, which also indicates positive changes in the energy sector.

Table 1

Total final energy consumption in Ukraine for 2007–2017 [9]

		Units of measurement	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	Total final energy consumption including	thousands toe	85955	83283	67555	74004	75852	73107	69557	61460	50831	51649	50086
2	Industry	thousands toe	32852	30942	22629	25327	26253	24845	21864	20570	16409	14955	15103
3	% In total	%	38,2%	37,2%	33,5%	34,2%	34,6%	34,0%	31,4%	33,5%	32,3%	29,0%	30,2%
4	Transport	thousands toe	15417	15141	12396	12627	12611	11448	11280	10327	8750	9165	9768
5	% In total	%	17,9%	18,2%	18,3%	17,1%	16,6%	15,7%	16,2%	16,8%	17,2%	17,7%	19,5%
6	Households	thousands toe	23001	22845	22084	23813	23604	23466	23495	20384	16554	17588	16435
7	% In total	%	26,8%	27,4%	32,7%	32,2%	31,1%	32,1%	33,8%	33,2%	32,6%	34,1%	32,8%
8	Sector of services	thousands toe	4956	4952	4176	4643	4802	5037	5745	4663	3838	4856	4396
9	% In total	%	5,8%	5,9%	6,2%	6,3%	6,3%	6,9%	8,3%	7,6%	7,6%	9,4%	8,8%
10	Agriculture, forestry and fisheries	thousands toe	2018	2107	1994	2036	2246	2195	2242	2016	1961	2143	1870
11	% In total	%	2,3%	2,5%	3,0%	2,8%	3,0%	3,0%	3,2%	3,3%	3,9%	4,1%	3,7%
12	Other spheres	thousands toe	0	0	7	10	327	0	0	0	0	31	0
13	% In total	%	0,0%	0,0%	0,0%	0,0%	0,4%	0,0%	0,0%	0,0%	0,0%	0,1%	0,0%
14	Non-energy use of energy	thousands toe	7712	7295	4269	5547	6008	6116	4932	3500	3318	2910	2515
15	% In total	%	9,0%	8,8%	6,3%	7,5%	7,9%	8,4%	7,1%	5,7%	6,5%	5,6%	5,0%

Table 2

Energy intensity for 2007–2017 [9]

		Units of measurement	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	GDP in PPP 2011	billion international dollars	395,2	404,3	344,5	358,9	378,5	379,4	379,3	354,5	319,8	327,2	335,4
Ultimate Power Consumption													
2	Ultimate Power Consumption	thousands toe	85955	83283	67555	74004	75852	73107	69557	61460	50831	51649	50086
3	Energy intensity	thousands toe /thousands international dollars	0,217	0,205	0,196	0,206	0,200	0,192	0,183	0,173	0,159	0,158	0,149
Total supply of primary energy													
4	Total supply of primary energy	thousands toe	139330	134562	114420	132308	126438	122488	115940	105683	90090	94383	89625
5	Energy intensity	thousands toe /thousands international dollars	0,352	0,332	0,332	0,368	0,334	0,322	0,305	0,298	0,282	0,288	0,267

The efficiency ratio of a fuel / price characterizes the price level for fuel, which should be at a certain period of time. Consequently, it shows the structure of real government expenditures on imported fuel and the change in fuel prices over a certain period. The value of the indicator is expressed in euro and should be as low as possible. Annual fuel efficiency / price efficiency ratio is expressed using the following formula:

$$EC_j = C_j Z_j, \tag{2}$$

Whereas, C_j – the price of energy,

Z_j – total energy consumption this year,

j – year number.

Thus, the total efficiency ratio of a fuel / price can be presented as follows [3].

$$ECP = \sum_{j=1}^{m} EC_j = \sum_{j=1}^{m} C_j Z_j. \tag{3}$$

Let's represent the total energy supply in Ukraine for 2007–2017 (Table 3). Let's calculate this figure for one, the most used type of energy in Ukraine – gas. As it can be seen, its use has become much smaller over the years, but one must take into account the exceptions to the review of the temporarily occupied Autonomous Republic of Crimea and the territories where military operations are currently being conducted. Calculate the fuel efficiency / price ratios for each year. Calculations are in euro.

Basing on the Table 4, we see that the rate of gas / price utilization efficiency varies slightly until the rise in prices in 2015, after which its value dramatically increases from 189357.25 to 714393.6621, but there is a further downward trend. Total ECP = 3931384 euros, which has the potential to decrease.

Let's analyze how diversified electricity production in Ukraine is by hydroelectric power plants, using the data on these objects from Table 5.

Table 5

Hydroelectric power stations [6]

№ n / p	The name hydroelectric power station	Volume of produced electricity (MW)	№ n / p	The name hydroelectric power station	Volume of produced electricity (MW)
1	Kyiv HPP	408,5	10	Dniester HPP	702
2	Kyiv HPSS	235,5	11	Dniester HPP-2	40,8
3	Kaniv HPP	444	12	Dniester HPSS	2268
4	Kaniv HPSS	1000	13	Constantine HPP	430
5	Kremenchug HPP	632,9	14	Tashlyk HPSS	320
6	Middle Dnipro	352	15	Oleksandrivska HPP	11,5
7	Dniprovska HPP	1569	16	Sukhorabiv HPP	0,3
8	Kakhovka HPP	351	17	Tereble-Ritska HPP	27
9	Kakhovka HPP-2	250	18	Shishatska HPP	0,55

Microeconomic market research suggests that a high concentration of production often leads to weaker competition. A high concentration of the energy market can lead to high prices for the proposed energy products, and hence higher profitability of their suppliers, which, however, creates a difficult situation for energy consumers. The most commonly used indicator of market concentration is the Gerfindahl-Hirschman index (HHI). It is defined as the sum of squares of parts on the market, including all firms participating in a particular market. The formula for HHI is denoted as follows:

$$HHI = \sum_{i=1}^{n} U_i^2 . \quad (4)$$

Where U_i – the market share of each of the manufacturers present on the market;

i – seller's index;

n – number of sellers on the market.

The interpretation of the results is as follows: if the value is close to 0, then it will be a highly competitive market structure, if the value is close to 10,000, then the market is a monopolistic entity. The value of the HHI index depends on the number of enterprises operating in the energy market and the uneven distribution of market shares.

If the index is below 0.1, it means a small market concentration. If the index is between 0.1 and 0.18, this means the average market concentration. If the index is above the 0.18 – this means a high concentration of the market. Taking into account the market shares, Table 5 will turn into Table 6.

Table 6

Share of energy produced by hydroelectric power plants of Ukraine (developed by the author)

№ n/p	The name hydroelectric power station	Volume of produced electricity (MW)	№4 n / p	The name hydroelectric power station	Volume of produced electricity (MW)
1	Kyiv HPP	0,045173	10	Dniester HPP	0,027646
2	Kyiv HPSS	0,026042	11	Dniester HPP-2	0,077629
3	Kaniv HPP	0,049098	12	Dniester HPSS	0,004512
4	Kaniv HPSS	0,110582	13	Constantine HPP	0,2508
5	Kremenchug HPP	0,069987	14	Tashlyk HPSS	0,04755
6	Middle Dnipro	0,038925	15	Oleksandrivska HPP	0,035386
7	Dniprovska HPP	0,173503	16	Sukhorabiv HPP	0,001272
8	Kakhovka HPP	0,038814	17	Tereble-Ritska HPP	3,32E-05
9	Kakhovka HPP-2	0,045173	18	Shishatska HPP	0,002986

Table 3

Total primary energy supply for 2007–2017 [9]

		Units of measurement	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017[2]
1	Energy production	thousands toe	84998	84260	79339	78712	85485	85247	85914	76928	61614	66323	58851
2	Import of energy	thousands toe	64975	65263	48506	51260	58055	46520	39722	34437	31575	29152	35261
3	Export of energy	thousands toe	7901	7984	7081	9278	10303	8007	8213	6967	1447	1427	1944
4	International marine and aviation bunkers	thousands toe	283	262	241	274	246	306	126	131	124	157	251
5	Stock changes	thousands toe	-2460	-6715	-6102	11888	-6552	-966	-1356	1417	-1529	492	-2291
6	Total supply of primary energy (line 1 + line 2 - line 3 - line 4 + line 5)	thousands toe	139330	134562	114420	132308	126438	122488	115940	105683	90090	94383	89625
	including												
7	Coal and peat	thousands toe	42657	41798	35870	38251	41490	42718	41427	35576	27344	32450	25696
8	% in total	%	30,6%	31,1%	31,3%	28,9%	32,8%	34,9%	35,7%	33,7%	30,4%	34,4%	28,7%
9	Crude oil	thousands toe	14926	11166	11384	11497	9100	5050	3978	3043	2851	2806	3351
10	% in total	%	10,7%	8,3%	9,9%	8,7%	7,2%	4,1%	3,4%	2,9%	3,2%	3,0%	3,7%
11	Petroleum products	thousands toe	291	3202	2518	1682	3360	6559	5928	7645	7700	8387	9507
12	% in total	%	0,2%	2,4%	2,2%	1,3%	2,7%	5,4%	5,1%	7,2%	8,5%	8,9%	10,6%
13	Natural gas	thousands toe	55586	52805	40789	55229	46841	43018	39444	33412	26055	25603	24554
14	% in total	%	39,9%	39,2%	35,6%	41,7%	37,0%	35,1%	34,0%	31,6%	28,9%	27,1%	27,4%
15	Atomic energy	thousands toe	24273	23566	21764	23387	23672	23653	21848	23191	22985	21244	22453
16	% in total	%	17,4%	17,5%	19,0%	17,7%	18,7%	19,3%	18,8%	21,9%	25,5%	22,5%	25,1%
17	Hydropower	thousands toe	872	990	1026	1131	941	901	1187	729	464	660	769
18	% in total	%	0,6%	0,7%	0,9%	0,9%	0,7%	0,7%	1,0%	0,7%	0,5%	0,7%	0,9%
19	Wind and solar energy, etc.	thousands toe	4	4	4	4	10	53	104	134	134	124	149
20	% in total	%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%	0,1%	0,1%	0,1%	0,2%
21	Biofuels and waste	thousands toe	1508	1610	1433	1476	1563	1522	1875	1934	2102	2832	3046
22	% in total	%	1,1%	1,2%	1,3%	1,1%	1,2%	1,2%	1,6%	1,8%	2,3%	3,0%	3,4%
23	Electricity	thousands toe	-789	-579	-367	-349	-541	-987	-851	-725	-116	-323	-445
24	% in total	%	-0,6%	-0,4%	-0,3%	-0,3%	-0,4%	-0,8%	-0,7%	-0,7%	-0,1%	-0,3%	-0,5%
25	Heat energy	thousands toe	...	...	...	...	...	...	1000	745	571	599	546
26	% in total	%	n/a	n/a	n/a	n/a	n/a	n/a	0,9%	0,7%	0,6%	0,6%	0,6%

Table 4

Determination of gas efficiency / price efficiency ratio (developed by the author basing on Archive of exchange rates, 2018 [5])

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Thousands toe	55586	52805	40789	55229	46841	43018	39444	33412	26055	25603	24554
Price, kop.	31,5	48,4	48,4	72,5	72,5	72,5	72,5	109	719	688	688
Sum	1750959	2555762	1974188	4004103	3395973	3118805	2859690	3641908	18733545	17614864	16893152
Euro exchange rate at the end of this year	741	1085,5	1144,9	1057,3	1044,6	1060,4	1093,8	1923,3	2622,3	2842,3	3349,5
Sum in euro	236296,8	235445,6	172433,2	378710,2	325097,9	294115,9	261445,4	189357,25	714393,6621	619739,7882	504348,4699

Let's calculate the HHI for our hydroelectric power plants. As a result, we get

$$HHI = \sum_{i=1}^{18} U_i^2 = 0,128617\,. \quad (5)$$

We conclude that the market concentration in the market of hydroelectric power is average. This is acceptable for the country, but if necessary, efforts should be made to reduce this concentration, that is, it is necessary to control the industry by the Antimonopoly Committee of Ukraine with respect to such power plants as Kaniv HPP, Dniprovska HES, and Kostyantyniv HPP, which have the largest share

Conclusions

The article provides an analysis of the development of some critical infrastructure sectors of the world, which form the basis of the security of their economies. The methods of determining the level of energy efficiency of the Ukrainian economy are implemented on the basis of world experience. It is proved that the energy intensity of the total supply of primary energy is reduced, which means the processes of positive changes in the energy industry. The efficiency rate of gas / prices has increased dramatically since 2015. The overall indicator has the potential to decrease. In connection with the average value of the Herfindahl-Hirschman index, we conclude that the control of the industry is required by the Antimonopoly Committee of Ukraine.

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ЕКОЛОГІЧНА ТА ЕНЕРГЕТИЧНА БЕЗПЕКА ЯК КОМПОНЕНТИ МІЖНАРОДНИХ ЕКОНОМІЧНИХ ВІДНОСИН

В статті представлено дослідження екологічної та енергетичної

безпеки як компоненти міжнародних економічних відносин. Оскільки водна сфера впливає на стан багатьох галузей, то проаналізовано вплив водорозподільних мереж на розвиток секторів національного господарства. Представлено базову модель водопостачання в економічній сфері, в якій виявлено фактори впливу на всі сектори економіки в кожній країні. Проаналізовано стан сфери водопостачання в Україні. Продовольчу галузь розглянуто з позиції прерогативи продовольчої безпеки в країнах, що розвиваються, що особливо стосується Економічного співтовариства країн Західної Африки. Констатовано, що бідність та продовольча безпека в Африці є головною проблемою економіки для багатьох країн. Доведено, що інтеграція є кращим інструментом для вирішення проблеми забезпечення продовольчої безпеки в країнах, що розвиваються. Запропоновано також дослідження однієї з найважливіших галузей критичної інфраструктури – енергетичної сфери. Опрацьовано оптимізацію роботи енергосистеми в КНР. Запроваджено аналіз енергоефективності в Україні. Для цього використано показник енергоємності, показник ефективності використання палива/ціни, індекс Герфіндаля-Гіршмана. За допомогою індекса енергоємності доведено, що споживання енергії в Україні стає більш ефективним. Значення коефіцієнту палива/ціни вказує на позитивну тенденцію у споживанні енергії в останні роки. Визначений індекс Герфіндаля-Гіршмана у гідроенергетиці показує, що ринкова концентрація на ринку гідроелектроенергії є середньою, що є позитивним явищем для України, однак при цьому необхідним є контроль галузі Антимонопольним Комітетом України.

Ключові слова: безпека; водні ресурси; продовольча безпека; енергоефективність; показник ефективності використання газу/ціни; індекс Герфіндаля-Гіршмана.

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ЭКОЛОГИЧЕСКАЯ И ЭНЕРГЕТИЧЕСКАЯ БЕЗОПАСНОСТЬ КАК КОМПОНЕНТЫ МЕЖДУНАРОДНЫХ ЭКОНОМИЧЕСКИХ ОТНОШЕНИЙ

В статье представлено исследование безопасности критической инфраструктуры, в первую очередь – водного хозяйства, которое влияет на состояние многих отраслей, в частности сельского хозяйства. Изучаются прерогативы продовольственной безопасности в развивающихся странах. Предлагается исследование одной из

важнейших отраслей критической инфраструктуры – энергетики. Представлен анализ энергоэффективности в Украине. Для этого использовали показатель энергоемкости, показатель газовой / ценовой эффективности, индекс Херфиндаля-Хиршмана.

Ключевые слова: безопасность; водные ресурсы; продовольственная безопасность; энергоэффективность; коэффициент полезного действия газа/цены; индекс Херфиндаля-Хиршмана.

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