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STATUS AND TRENDS OF INNOVATIVE DEVELOPMENT OF UKRAINIAN ENERGY

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Кандеева В.В. Стан та тенденції інноваційного розвитку енергетики України.

В статті проведено аналіз поточного стану енергетики України, досліджено стан та тенденції інноваційного розвитку енергетики України на основі вітчизняного та світового досвіду. Розглянуто вплив інноваційного розвитку енергетики на економічну та енергетичну незалежність країни.

Ключові слова: інноваційний розвиток, енергетика, енергозбереження, енергоефективність

Kandeeva V.V. Состояние и тенденции инновационного развития энергетики Украины.

В статье проведен анализ текущего состояния энергетики Украины, исследовано состояние и тенденции инновационного развития энергетики Украины на основе отечественного и мирового опыта. Рассмотрено влияние инновационного развития энергетики на экономическую и энергетическую независимость страны.

Ключевые слова: инновационное развитие, энергетика, энергосбережение, энергоэффективность

Kandeeva V.V. Status and trends of innovative development of the Ukrainian energy.

The article analyzes the current state of the energy sector of Ukraine, studied the state and trends of innovative development of Ukraine's energy sector on the basis of domestic and international experience. The influence of innovative energy development in the economic and energy independence of the country.

Keywords: innovative development, energy, energy conservation, energy efficiency

Today, innovations have the primary and determining role in the development of the country and stabilize the economy. Energy leads the industries that create the necessary conditions for the formation and functioning of industrial complex of the country and population. A major component of economic development and the welfare of the state is the provision of energy. That is why the study of the status and trends of innovation development of Ukraine's energy sector is extremely important.

One of the most important components of wealth in civilized States is to provide citizens and companies with the necessary energy. The key to the implementation of this goal should be a reliable, economically sound and environmentally safe satisfaction of needs of population and economy in the energy products. Instead of providing extensive development, which Ukraine's economy moving for decades, and it needs to go on an effective sustainable development of the economy. Providing economy and social sphere in the country major types of energy (electric and thermal energy, motor and boiler and stove fuels, and natural gas) and raw materials for the needs of the chemical and metallurgical industry (coking coal products oil and gas refining) is imposed on fuel and energy complex of Ukraine [1].

Analysis of recent researches and publications

The study of problems of innovative development have devoted their scientific works of domestic and foreign scientists, such as: G. Alexander, A. Amosha, Jeffrey W. Bailey, Daniel Bell, V. Geyets, B. Grinyova, P. Drucker, V. Denisenko, V. Zakharchenko, S. Piyashenko, G. Kozachenko, B. Malitskiy, A. Trifilova, I. Tukkel, L. Fedulova, O. Yastremska and other. The theme of energy saving and energy efficiency was investigated, in particular, scholars such as A. Tson [2], H. Jiang [3], I. Zapuhlyak [4], Y. Kostin, L. Taranyuk and others.

The aim of the article is analysis of the status and trends of innovation development of Ukraine's energy sector on the basis of statistical information, taking into account world achievements.

The main part

Unstable political and economic situation in the world and the redistribution of energy leads to the change of the course of world energy development. The world community faces the challenge of identi-

fyng new opportunities in using both traditional and renewable energy resources.

One of the most urgent and pressing problems of contemporary development of the global community is the growing shortage of traditional energy. The developed countries would find it challenging to implement new energy saving technologies the use of organic (oil, gas, coal) energy resources with minimal impact on the environment if a reasonable and adequate satisfaction of industrial and domestic needs, as well as search and implementation of new alternative energy sources. For Ukraine, with its backward technology for the use of traditional energy resources and increasing prices, primarily gas, search and implementation of new concepts in powering economic complex of the country is a crucial factor in stabilizing the development of the economy and the condition of its sustainable development [5].

According to the Law of Ukraine on priority directions of innovative activity in Ukraine are defined as "scientifically and economically substantiated and defined in accordance with the present Law the areas of production innovation activities aimed at ensuring economic security of the state, the creation of competitive high-tech environmentally friendly products, to provide high quality services and increase of export potential of the state with effective use of domestic and world scientific and technical achievements". Priority directions of innovative activity in Ukraine consist of strategic (long-term – at least ten years) and

medium term (which is to be implemented over the next three to five years [6].

In accordance with the priority directions of innovative activity in Ukraine for the period 2011 to 2021 for the energy industry, defined:

- familiarization of new technologies for transport the energy;
- implementation of energy-efficient, resource-saving technologies;
- familiarization alternative sources of energy [6].

The main sources of energy in Ukraine are:

- Thermal Power Station (TPS)
- Nuclear Power Plant (NPP)
- Hydro Power Plant (HPP) and Pumped Storage Pump-up Plant (PSPP)
- Wind Power Plant (WPP)
- Solar Electric Generating Station (SEGS).

United energy system (UES) of Ukraine, is the energy foundation of the country. UES transits, buying and selling of energy, energy needs of the country and interaction with partners in the energy sector. In table 1 and 2 presents the characteristics UES of Ukraine by types of generating companies in 2009-2012. From table 2 we can see that there is a tendency of increasing the electric power plants of the UES of Ukraine. According to the results of 2012 compared to 2011, electricity production in Ukraine increased by 2%.

Table 1. Installed capacity of power plants UES of Ukraine (2009-2012) [7]

Generation companies	2009		2010		2011		2012	
	million kW	%	million kW	%	million kW	%	million kW	%
TPS	27,26	51,47	27,35	51,44	27,27	51,15	27,41	50,97
TPP and other TPS	6,37	12,02	6,43	12,1	6,43	12,06	6,54	12,16
NPP	13,84	26,12	13,83	26,02	13,84	25,96	13,84	25,73
HPP, PSPP	5,41	10,23	5,45	10,25	5,47	10,26	5,41	10,06
WPP	0,08	0,16	0,09	0,17	0,12	0,23	0,26	0,48
SEGS	-	-	0,01	0,02	0,18	0,34	0,32	0,6
TOTAL	52,96	100	53,16	100	53,31	100	53,78	100

Table 2. Electricity generation by power plants UES of Ukraine (2009-2012) [7]

Generation companies	2009		2010		2011		2012	
	billion kWh	%	billion kWh	%	billion kWh	%	billion kWh	%
TPS	63,2	36,51	67,83	36,06	73,71	37,97	78,91	39,83
TPP and other TPS	15,17	8,76	18,11	9,65	19,25	9,92	17,63	8,9
NPP	82,92	47,9	89,15	47,38	90,25	46,5	90,14	45,5
HPP, PSPP	11,77	6,8	12,96	6,88	10,77	5,54	10,83	5,46
WPP	0,04	0,03	0,05	0,03	0,09	0,05	0,28	0,14
SEGS	0	0	0	0	0,03	0,02	0,33	0,17
TOTAL	173,1	100	188,1	100	194,1	100	198,12	100

And in 2014 the share of NPP in the structure of electricity production amounted to 48,4% (in 2013 – 43%), TPS and TPP – 41,3% (44,7%), HPP and PSPP – 5% (7,3%), public utility TPP and unit-stations - 4,3% (4,3%), alternative sources – 1% (0,6%). In 2014 nuclear power plant (NPP) increased electricity generation by 6,2% to 88 billion 389300000 kWh.; thermal power stations (TPS) and combined heat and power (TPP) reduced production by 12,9% to 75

billion 371100000 kWh.; hydroelectric plant (HPP and PSPP) in 2014 has reduced production by 3,6% to 9 billion 92600000 kWh; TPP and unit-stations – by 6,3%, to 7 billion 789300000 kWh; electricity production from unconventional sources (WPP, SEGS, biomass) for the period increased by 42,1% to 1 billion 771900000 kWh. In 2013, SEGS showed is 1,37% and WPP – 0,68% [8].

Active development of power industry of Ukraine was in USSR times, and today the deterioration of the equipment at power plants has reached a critical maximum. Factors such as rising prices for traditional fuels on the world market, the limits of consumption, lack of own fuel and energy resources, reduction of consumer properties and energy dependence on imported basic process equipment should give food for thought about approaches to solving energy problems. This solution could be the production of electricity through unconventional (alternative) sources especially that in Ukraine there are all conditions. Great potential for development include:

- hydropower – South and West of the country;
- wind power – West (mountain area), South and East (steppe zone);
- solar energy is the South of Ukraine;
- bioenergy – center of Ukraine.

One of the positive moments in the electric power industry is the lack of the fuel component and the low price on this energy and experience in the production and operation of hydraulic equipment.

Today in Ukraine wind power has not yet reached significant proportions, although it is considered one of the promising directions in the field of alternative energy. The country has 18 WPP and in 2014 they produced electricity 0,62% of the total electricity production in Ukraine. The use of solar energy in Ukraine has very high potential.

One of the most positive points is the geographical location of our country. Virtually the entire territory of Ukraine meets the requirements of the solar energy, has a high potential for the South of the country.

All alternative energy sources have multiple positive aspects: don't require mining, accessibility to the original, environmental cleanliness, there is no problem of waste disposal. But there are also negative sides – season. Therefore alternative energy sources are better be combined with traditional sources of energy or between traditional sources of energy.

In 2011 audit company Ernst & Young for the first time included Ukraine in the country attractiveness index for investments in renewable energy. In early 2012, Ernst & Young has again assessed the prospects of investment in the development of alternative energy in Ukraine. Ukraine belongs to the markets that showed growth in 2012, while developed countries (Germany, USA, UK, Australia) are forced to limit their growth. Ernst & Young noted the law on green tariffs in Ukraine as an example of successful programs for the development of renewable energy. Ukraine retained its position in the overall index – 32nd place. Around Ukraine is located in Turkey (30 position), Austria (33 position), Argentina, Bulgaria and Tunisia shared 34th place. First-fifth place retained the China, USA, Germany, India and the UK. The highest rate of Ukraine in the rating of solar energy is on the 23rd place along with Canada and Romania [9].

In 2013, the international Agency Bloomberg Rankings has presented the ranking of innovative

countries in the world. In the ranking of innovative development is influenced by seven factors relevant to scientific, educational and technological spheres. In it, Ukraine is in the 42nd place (out of 96 countries). The level of intensity of research Ukraine at the 37th place, concentration of high technology – 47th, the number of scientists – 39th, the performance of the industry – 34th, of education – on the 6th. It should be noted that in the first place in the ranking of the United States, South Korea, – 2nd place, Germany – 3rd, Finland – 4th Sweden – 5th. Ukraine was between Greece (41st) and Bulgaria (43rd) [10].

In the modern world, economic growth is associated with the development of high technology, machines, machinery, equipment, everything that allows you to replace manual human labor. And this, in turn, leads to increased energy consumption. The countries with a developed energy system, the main task are reduction in energy intensity of GDP. The solution of this problem allows to reduce technological losses of energy, which plays an important role to improve the quality of manufactured products.

Table 3 presents the structure of electricity consumption in Ukraine in 2013 and 2014 by category of consumption. The table shows that in recent time there is not a significant reduction in electricity consumption the reduction is only due to the industrial sector, while the decline in consumption among the population is not happening. This is due to the increase in the standard of living of the population and the use of a large number of energy-consuming equipment in the home. Industry accounts for almost half of the total power consumption of 45,3%, and the main consumer industries are metallurgy – 25, 3% of total consumption. If we consider the whole structure of electricity consumption in Ukraine for the period of 2013–2014, the leadership is population, consuming electricity in percentage terms even more than the industry of metallurgy.

According to the Statistical Yearbook Enerdata world energy world primary energy production (oil, natural gas, coal, nuclear and hydropower) in 2014 increased by 1,1% and in energy consumption – stagnation. In tables 4 and 5 present the world production of primary energy and consumption of energy (Mtoe is a unit of energy, translation of the calories in the millions tons of oil equivalent) in the period from 2010 to 2014, countries – leaders [12].

As shown in table 5 in the leading countries, energy consumption has not changed. Leadership of global energy consumption since 2010 is firmly entrenched in such countries as China and the USA. The countries – leaders are interested in development of export potential. The main growth of global energy consumption driven by emerging countries. Despite the fact that world population and world GDP are growing, the primary energy consumption has slowed. So the average annual growth rate of primary energy consumption amounted from 2003 to 2007 – 3%, from 2008 to 2013 – 2,2%, in 2013 – 2%, in 2014 – 0,9%.

Table 3. Structure of electricity consumption in Ukraine (2013 and 2014) [11]

Consumers	2013, million kWh	2014, million kWh	var., million kWh	var., %	2013, p, %	2014, p, %
Use of electricity (gross)	183 732,0	171 507,0	-12 225,0	-6,7		
Use of electricity (nett)	141 507,4	134 854,3	-6 653,2	-4,7	100,0	100,0
which includes:						
1. Sector of industry	65 484,7	61 094,2	-4390,5	-6,7	46,3	45,3
which includes:						
— metallurgical	35 035,0	34 102,6	-932,4	-2,7	24,8	25,3
— fuel	8 517,6	7 391,3	-1 126,3	-13,2	6,0	5,5
— mechanical-engineering	5 175,8	4 361,3	-814,5	-15,7	3,7	3,2
— chemical and petrochemical	4 517,2	3 802,0	-715,2	-15,8	3,2	2,8
— food and processing	4 558,8	4 504,4	-54,4	-1,2	3,2	3,3
— building materials	2 420,7	2 223,8	-197,0	-8,1	1,7	1,7
— other	5 259,6	4 708,8	-550,9	-10,5	3,7	3,5
2. Agricultural Consumers	3 635,8	3 506,4	-129,5	-3,6	2,6	2,6
3. Transport	8 451,7	7 322,0	-1 129,7	-13,4	6,0	5,4
4. Construction	941,5	842,8	-98,6	-10,5	0,7	0,6
5. Household consumers	17 701,9	16 502,0	-1 199,9	-6,8	12,5	12,2
6. Other non-industrial consumers	6 556,5	6 434,6	-121,8	-1,9	4,6	4,8
7. Population	38 735,4	39 152,2	416,8	1,1	27,4	29,0

Table 4. Primary energy production

№	Country	Unit: Mtoe				
		2010	2011	2012	2013	2014
1	China	2,262	2,433	2,527	2,565	2,555
2	USA	1,725	1,786	1,808	1,870	1,989
3	Russia	1,293	1,315	1,331	1,346	1,334
4	Saudi Arabia	531	593	625	620	630
5	India	530	539	545	549	571
6	Indonesia	380	423	440	466	457
7	Canada	395	407	419	434	452
8	Australia	309	297	317	343	357
9	Iran	350	354	303	292	308
10	Nigeria	257	264	272	259	261
					
	Ukraine	79	86	85	83	76

Table 5. Energy consumption

№	Country	Unit: Mtoe				
		2010	2011	2012	2013	2014
1	China	2,526	2,747	2,893	3,041	3,034
2	USA	2,217	2,192	2,142	2,201	2,224
3	India	722	752	788	817	872
4	Russia	703	738	756	751	751
5	Japan	499	462	452	450	437
6	Germany	328	311	313	321	307
7	Brazil	266	270	282	295	306
8	South Korea	253	265	271	273	277
9	Canada	252	254	251	252	251
10	France	261	251	252	254	243
					
	Ukraine	133	127	123	117	103

Today a large role played by the consumption, therefore, the leaders of major industrial companies focus on energy saving and increasing energy efficiency of production. In today's world, the main role of technology, they determine the economic strength of the country, they have a huge impact on

the development of the global energy market, leading to fierce competition. The development of energy technologies for Ukraine is the main tool to improve its energy efficiency and the revitalization of the industrial base.

Table 6 presents the intensity of energy use per unit of GDP in 2000-2014 (expressed in constant rates of exchange rate and purchasing power parity or

kilogram oil equivalent / US dollar in 2005 prices at constant purchasing power parity).

Table 6. The intensity of energy use per unit of GDP

№	Country	Unit: kep/\$2005				
		2000	2005	2010	2013	2014
1	Russia	0,491	0,384	0,348	0,340	0,340
2	Uzbekistan	0,931	0,662	0,405	0,352	0,333
3	Ukraine	0,613	0,468	0,413	0,339	0,320
4	RSA	0,292	0,285	0,270	0,248	0,252
5	Iran	0,196	0,209	0,199	0,215	0,225
6	Taiwan	0,277	0,286	0,252	0,228	0,224
7	Kazakhstan	0,278	0,242	0,243	0,227	0,219
8	China	0,286	0,274	0,229	0,218	0,203
9	Canada	0,245	0,233	0,204	0,191	0,186
10	South Korea	0,205	0,183	0,178	0,175	0,171

Among the countries of the world Ukraine is firmly in the top three in the energy intensity of GDP and is one of the largest energy consumers, in competition with Uzbekistan and Russia. The largest consumers of energy resources are such sectors as industry and the population of Ukraine their share is 45.3% and 29% respectively. The negative moment is an industry that works on technologically outdated and physically worn out, energy consuming equipment, low level of energy efficient technologies and equipment. Over the past 25 years, the industry has experienced a huge lack in funding, which led to substantial wear. The energy directly involved in the formation of production costs industry. Statistics of industry in electricity consumption (table 3) shows that a drastic reduction of energy consumption is not observed. This result means that the efficiency remains at the same level as was planned in the design of the enterprise. The energy intensity of Ukrainian industry in 3-3,5 times higher than in countries such as Poland (0.129 cap / \$ 2005), Romania (0.128 kep / \$ 2005), China (0.123 kep / \$ 2005), Japan (0.107 kep / \$ 2005) Germany (0.106 kep / \$ 2005). Despite positive results, leading countries today consider the issue of reducing energy intensity actual. Western countries are paying great attention to the issues of energy efficiency and energy saving. In Poland, France, Germany, Italy, pay great attention to modernization of power units. The USA government initiated financial support for research and development long-term programs in the field of energy. Europe is interested in the development of alternative energy. All the efforts of the international community aimed at improving energy efficiency have yielded positive results. In 2014 has been marked by intense decline in the intensity of energy use in Europe.

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Conclusions

Innovative energy development contributes to the development of the industrial complex of the country and quality of life support of the population. On the basis of the conducted research it can be argued that the innovative energy development plays a crucial role in the economy of the country.

After analyzing world production and consumption of energy, we can conclude that economic development needs innovative energy development. Today in energy changes associated with change of energy source. In the period of technological transformation of the world community, in energy, firmly on innovative development, namely the introduction of new energy-efficient and energy-saving technologies.

Today, the prospects of innovative development of Ukraine's energy sector are a difficult task. Energy is interested in the implementation of innovation, however, technologically backward and physically worn out, energy consuming equipment, it is very difficult to make radical innovative changes.

Ukraine needs to move toward becoming a big energy producer, taking a course on innovative development in the field of energy. To do this necessary:

- holding energomaterialy to reduce energy consumption;
- activities on energy efficiency and development of energy-saving technologies;
- increase efficient use of alternative energy;
- increase the use of secondary energy resources.

All these activities require serious support from the state and investors. Despite the fact that the energy sector was identified as a priority in the innovation activity of Ukraine, while it is not necessary to speak about activity and wide application.

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