The simplified estimation of energy security level on the basis of available information.

Vasikov A.R., Salikhov T.P., Garaev Z.N.

In the paper presented the method for the simplified estimation of energy security with using available information data of International Energy Agency and United Nations Development Programme has been proposed. The method developed allows to estimate quantitatively a level of national energy security and to make cross country comparison. Applying this procedure, the results of calculations for 130 countries of the world have been obtained and comparative analysis of the level of the energy security has been made.

***Index Terms*: energy security, energy consumption, estimates of a quantitative level.**

It was noted in the report of UNECE Secretariat of Committee on sustainable energy that energy security again becomes a key economic problem.

Many countries joined their efforts to solve this problem. For example, in Energy Strategy of Russia the main strategic directions of the long-term state energy policy for the period till 2030 are: energy security, energy efficiency of economy, budgetary efficiency and ecological security of energy. «The Concept of energy security of Belarus», was approved on 17th September, 2007. This document provides 12 threshold values - parameters which determine the energy security.

The efforts of Japan, Republic of Korea, Poland, Georgia and many other countries are also directed to provide own national energy security. Thus, each country considers concept of «energy security» in its own way, and on this base develops national systems of indicators; and using these national systems of indicators, a country makes a quantitative estimation and the analysis of the current and perspective level of energy security.

It has usually been used no more than 5-6 basic macroeconomic parameters in order to estimate the level of energy security in the majority of economically developed countries. The level of energy security in Russia is estimated with 10 up to 122 parameters, the system of 27 basic parameters determines the level of energy security in Moldova, and 12 indicators determine the level of energy security in Belarus.

There are even proposals to estimate energy security with only one parameter - a share of own energy resources in total amount of consumption.

The variety of the parameters of energy security leads to difficulty of making comparisons between countries. Besides, only local researchers have an access to many initial data used for carrying out estimations of a level of energy security.

For these conditions there is a nerd to develop a procedure of a simplified estimation of energy security using available information which would allow to estimate quantitatively a level of national energy security and to make comparisons applying this parameter to different countries.

Earlier, to decide this problem we have proposed a procedure for quantitative estimation of energy security with using the parameters of energy production, diversification of structure of energy consumption and a level of energy consumption per capita. However, separate conceptual positions of the procedure have caused a reasonable criticism leading to some corrections to be made for the model developed.

A.R.Vasikov, T.P.Salikhov, Z.N.Garaev, Institute of Power Engineering and Automation of Uzbekistan Academy of Sciences, 29, Durmon yoli, Academgorodok, Tashkent, 100125, Republic of Uzbekistan (e-mail: temur@energy.uzsci.net)

In particular, technique for estimation of a level energy provision has been changed; the new parameters connecting with energy consumption per capita, structure of primary energy consumption and efficiency of system of power supply have been taken into account.

In this point of view the following parameters have been accepted as the key factors determining a level of energy security of the countries:

provision by own sources of primary energy,

possibility of providing internal energy consumption due to additional import of energy resources,

human resources giving possibility to solve the problem of energy security and effectively to maintain complex systems of power,

efficiency of national system of power supply.

The level of energy self-sufficiency is determined by the relation of volumes of local production and consumption of primary energy and calculated according to energy balance (available on the web-site of the International Energy Agency (IEA)). Since this parameter for the different countries can reach multiple units to reduce it to comparable variable it is proposed to enter a special normalized index (energy provision index) which will vary from 0 up to 1.

The given index is calculated by the formula:

$$I_{si} = \frac{S_{if} - S_{\min}}{S_{\max} - S_{\min}}, \qquad (1)$$

Where S is the parameter of energy self-sufficiency which is determined as the relation of total production to total consumption of primary energy S_{if}, $S_{\min}, S_{\max}$ - accordingly the minimal and maximal energy provisional for ***i*** country accepted for the calculation. According to IEA in 2007 the Republic of Kongo had the maximal excess of production of primary energy over its consumption (in 9,9 times) .

The possibility to provide internal energy consumption by the import of energy is determined by a level of economic development of the country, and ability of Human resources to solve the problem of energy security and effectively to maintain complex power systems are determined by a level of literacy and education of the population. These two parameters are characterized by the Human Development Index of the United Nations Development Program (a human development index I_{hdi}). Components of this index are life expectancy index, education index and gross domestic product index.

The choice of this integrated parameter is connected with the following reasoning. The high level of economic development, literacy and education give the possibility to compensate lack of own energy sources and to provide effective operation of complex power systems - power stations, oil refining, gas conversion plants, systems for large scale transportation of fuel and energy.

Efficiency of national system of power supply (energy efficiency index I_{eei}) is determined by a level of expenses of various kinds of primary energy on their extraction, transformation, transportation and distribution. The parameter is calculated according to energy balance, as the relation of final consumption to total consumption of primary energy.

In this case a level of energy security is calculated by the formula (at the condition that parameters of energy provision and human development potential are equivalent from energy security point of view)

$$I_{bi} = \frac{(I_{hdi} + I_{si})}{2} \times I_{eei}, \qquad (2)$$

Where I_{bi} is an index of energy security of the country; is index of human development potential; is energy efficiency index.

The given parameter can vary from 0 up to 1, that corresponds to the lowest and highest levels of energy security of the country.

Using the given technique, we have calculated of a level of energy security for 131 countries of the world. For the calculation the data of International Energy Agency and the Human Development Report have been used.

The results of calculation of parameters of energy security for the separate countries of the world are given in Table 1.

TABLE 1 PARAMETERS OF ENERGY SECURITY

№ №	The Countries	The Index of human development	The Index of energy provision	The Index of energy efficiency	The Index of energy security
		I_{hd}	I_s	I_{ee}	I_b
1	Norway	0,971	0,807	0,784	0,697
2	Congo Republic	0,601	1,000	0,712	0,570
3	Canada	0,966	0,155	0,761	0,427
4	Libya	0,847	0,577	0,567	0,404
5	Austria	0,955	0,033	0,812	0,401
6	Netherlands	0,964	0,077	0,755	0,393
7	Venezuela	0,844	0,292	0,678	0,385
8	Italy	0,951	0,015	0,782	0,378
9	Algeria	0,754	0,451	0,624	0,376
10	United Arab Emirates	0,903	0,350	0,600	0,376
11	Iran	0,782	0,177	0,782	0,375
12	Saudi Arabia	0,843	0,371	0,617	0,375
13	Qatar	0,910	0,470	0,538	0,371
14	Australia	0,970	0,236	0,612	0,369
15	Finland	0,959	0,044	0,733	0,368
16	Argentina	0,866	0,114	0,749	0,367
17	Brazil	0,813	0,093	0,806	0,365
18	Sweden	0,963	0,067	0,681	0,351
19	Azerbaijan	0,787	0,443	0,568	0,349
20	United States	0,956	0,072	0,679	0,349
21	United Kingdom	0,947	0,084	0,676	0,349
22	Germany	0,947	0,042	0,704	0,348
23	Spain	0,955	0,021	0,712	0,348
24	Indonesia	0,734	0,176	0,761	0,346
25	Kazakhstan	0,804	0,207	0,672	0,340
26	Turkmenistan	0,739	0,370	0,593	0,329
27	Japan	0,960	0,018	0,665	0,325
28	Russian Federation	0,817	0,185	0,640	0,321
29	Hungary	0,879	0,039	0,699	0,321
30	Poland	0,880	0,076	0,668	0,319
31	Turkey	0,806	0,028	0,765	0,319
32	France	0,961	0,052	0,626	0,317
33	Korea, Republic	0,937	0,019	0,661	0,316
34	Kuwait	0,916	0,589	0,417	0,314
35	Uzbekistan	0,710	0,125	0,750	0,313
36	Mexico	0,854	0,138	0,623	0,309
37	Lithuania	0,870	0,042	0,673	0,307
38	Belarus	0,826	0,014	0,722	0,303
39	Romania	0,837	0,072	0,660	0,300
40	Kyrgyzstan	0,710	0,050	0,788	0,299

41	Georgia	0,778	0,032	0,724	0,293
42	Egypt	0,703	0,124	0,707	0,292
43	Armenia	0,798	0,029	0,705	0,292
44	Czech Republic	0,903	0,075	0,589	0,288
45	Malaysia	0,829	0,132	0,598	0,287
46	Serbia	0,826	0,062	0,635	0,282
47	Thailand	0,783	0,058	0,670	0,282
48	Israel	0,935	0,012	0,588	0,278
49	China	0,772	0,094	0,638	0,276
50	Estonia	0,883	0,079	0,565	0,272
51	Syria	0,742	0,126	0,624	0,271
52	Iceland	0,969	0,082	0,512	0,269
53	Pakistan	0,572	0,077	0,828	0,269
54	Ukraine	0,796	0,060	0,600	0,257
55	Bahrain	0,895	0,197	0,468	0,255
56	Bangladesh	0,543	0,084	0,773	0,242
57	Morocco	0,654	0,005	0,723	0,238
58	Bulgaria	0,840	0,050	0,527	0,234
59	Singapore	0,944	0,000	0,495	0,234
60	Congo D.Republic	0,389	0,103	0,939	0,231
61	Philippines	0,751	0,057	0,572	0,231
62	Brunei Darussalam	0,920	0,738	0,277	0,230
63	Ghana	0,526	0,069	0,767	0,228
64	India	0,612	0,077	0,660	0,227
65	Moldova, Republic of	0,720	0,003	0,611	0,221
66	Kenya	0,541	0,081	0,662	0,206
67	Mozambique	0,402	0,122	0,775	0,203
68	South Africa	0,683	0,120	0,484	0,194
69	Malta	0,902	0,000	0,419	0,189
70	Cote d'Ivoire	0,484	0,114	0,537	0,161

It can be seen in the Table that the countries rich in energy resources, having developed human potential and small expenses of primary energy in power supply systems are characterized by high level of energy security.

CONCLUSIONS

In our opinion, application of proposed method allows to make a quantitative estimation of a level of energy security of the country and comparisons of this parameter for different countries at using a minimum quantity of the available information.

The method can be used for the retrospective analysis and forecasting energy development of the country; it is also useful for developing objective parameters and making estimations in the levels of their achievement.

REFERENCES

[1]. Доклад о ходе исследования ЕЭК ООН по вопросу устойчивой энергетической политики в целях уменьшения рисков в сфере энергетической безопасности. ECE/ENERGY/2008/2. 10 September 2008

[2]. Энергетическая стратегия России на период до 2030 года. Утверждена распоряжением Правительства Российской Федерации от 13 ноября 2009 г. № 1715-р.

[3]. «Энергетика и ТЭК» № 2 (59), февраль 2008 Новая Концепция энергетической безопасности. http://energetika.by/arch/~year__m21=2008~month__m21=2~page__m21=1~news__m21=64

[4]. New National Energy Strategy. Press Release. May 31, 2006.Agency for Natural Resources and Energy.

[5]. Young-Chang Kim. KEEI. Electric Power Industry in Korea. 2008.

[6]. Guidelines for Energy Policy of Poland until 2020. http://www.mg.ov.pl/prawo/energia/index.htm

[7]. Презентация Зам. министра энергетики Грузии И.Новрузова «Повышение энергетической безопасности Грузии». 2006 г.

[8]. Митрова Т.А. Проблемы глобальной энергетической безопасности. Информационно-аналитический материал. Москва, 2006.

[9]. Григорьев Л. Энергетика: каждому своя безопасность. Институт Энергетики и Финансов (Россия). 2006 г. http://www.polit.ru/lectures/2006/08/04/grigoriev.html

[10]. Митрова Т.А. (ИНЭИ РАН). Фактор энергетической безопасности в экономическом развитии регионов мира. Конгресс Международного Союза экономистов, Швейцария, 2008 г.

[11]. А.В.Корнеев. Энергоэффективность экономики России и международное сотрудничество. Текст научного доклада на международном форуме IC ENERGY Limited «Энергоэффективность и энергосбережение в России: эволюция бизнеса», Москва, 25-26 февраля 2010 г. http://webcenter.ru/~akorneev/

[12]. Береснева Н.М. Система поддержки индикативного анализа энергетической безопасности России. Автореферат диссертации на соискание ученой степени кандидата технических наук. 2008.

[13]. Л.В. Массель, Е.А. Болдырев Оценка уровня энергетической безопасности с использованием нейросетей. http://library.mephi.ru/data/scientific-sessions/2001/Neuro_2/2334.html

[14]. Литвак В.В., Силич В.А., Яворский М.Й. Концепция энергетической безопасности субъектов федерации. Электронный журнал энергосервисной компании «Экологические системы», №1, январь 2006

[15]. Дука Г.Г., Постолатий В.М. Аспекты проблемы энергетической безопасности Республики Молдова Журнал «Электро» №4, 2005 г.

[16]. Войкова Н.А. Беленцов В.Н. Интегральная оценка электроэнергетической независимости государства. dspace.nbuv.gov.ua:8080/dspace/bitstream/.../2663/.../st_39_3.pdf

[17]. А.Р.Васиков, Т.П.Салихов, З.Н.Гараев. О количественной оценке уровня энергетической безопасности страны. Узбекский журнал «Проблемы информатики и энергетики». 2009 г. №6

[18]. International Energy Agency (IEA). Energy Balance. OECD/IEA, 2010

[19]. Доклад о развитии человека 2007/2008. Борьба с изменениями климата: человеческая солидарность в разделённом мире / Пер. с англ. – М.: Издательство «Весь Мир», 2007г.

[20]. Доклад о развитии человека 2009. «Преодоление барьеров. Человеческая мобильность и развитие». Издательство «Весь Мир». 2009 г.

BIOGRAPHIES

Temur Pattakhovich Salikhov – Director of the Institute of Power Engineering and Automation of Uzbekistan Academy of Sciences, Doctor of Technical Sciences, Professor.
Graduated from Moscow Power Engineering Institute in 1977. Sphere of scientific interests are thermo physical properties of advances materials at high and super high temperatures, synergy and nonlinear dynamics, forecasting energy development, mechanisms of energy efficiency, energy policy.

Abdumajid Rakhimovich Vasikov – senior research fellow of the Institute of Power Engineering and Automation of Uzbekistan Academy of Sciences. Graduated from Tashkent Polytechnical Institute in 1971. He had worked in economical institutions of the Republic of Uzbekistan. Sphere of scientific interests is forecasting energy development.

Zarif Nailevich Garaev – post-graduate student of the Institute of Power Engineering and Automation of Uzbekistan Academy of Sciences. Graduated from Tashkent Technical University in 2008. Sphere of scientific interests are forecasting energy consumption on the base of advanced information technology, synergy and nonlinear dynamics.