The role of energy sector infrastructure in world economy development

Elena Sergeevna Akopova, Anna Alexandrovna Polubotko

Rostov State Economic University, Large Garden, 69, Rostov-on-Don, 344007, Russia

Abstract. The article is devoted to the role identification of the energy sector infrastructure in world economy development. Authors analyze key trends of energy sector development and long-term forecasts, concerning prospects for energy sector development, identify the dependence between energy sector infrastructure and world economy development, they also make a mathematical economic model of world economy sector infrastructure development.
[Akopova E.S., Polubotko A.A. **The role of energy sector infrastructure in world economy development.** *Life Sci J* 2014;11(11s):560-564] (ISSN:1097-8135). http://www.lifesciencesite.com. 128

Keywords: infrastructure, Energy sector, world economy, development, industrial output

Introduction

In "Energy Vision 2013", prepared within the context of World economic forum, the following key trends in energy sector development are pointed out [1]:

- Variety growth of energy sources in energy market due to the regeneration of renewable energy sources, which became an essential business, revenues from which exceeded 184 billions of dollars in 2013. Now it is a global industry. Its growth was praised by the mixture of scientific researches and government policy improvement (subsidies and stimuli).
- Progress in technological development and considerable reduction of costs for wind, solar and biomaterial energy production accompanied this growth.
- Changing of the energy sector structure at the cost of natural coal production and the consume increase almost twofold. Coal stake in energy sector increased almost three times the size of oil stake, and ten times more than the stake of renewable energy sources. This is a result of high rate of economy growth in the countries with developing market. The stake of natural gas is expected to rise twofold for the next two decades.
- The oil is slowly losing its positions in energy complex. Under the influence of variety of social, political, economical and ecological factors, the market of electro mobiles was formed; the source of whose is electricity, the renewable energy source.

If the electro mobile production become large-scale and not niche, it will become the last oil mainstay, it's almost full domination as the automobile fuel would be destroyed. However, currently a competitive position of oil continues to be very high.

Long-term forecast, concerning prospects of energy sector development are made:

- In the nearest two decades the price for energy sources will directly depend on their value for the world consumers. Upon these conditions the political factors influence the energy sources price-forming, which will spiral down and be minimized.
- In 2020-2030-s an overall accent on innovation and technology in energy complex is expected. As the result of technique and technology perfection there will be increase in speed, refinement and energy sources supply, which will accordingly bring the speed-up of technological transactions in energy complex.
- The increase in energy sources demand will lead to the aggravating problem of their shortage in nearest 20 years. Nowadays almost 1.3 billion of people have no access to the energy sources. By 2020 their amount may increase to 3 billion, and by 2030 – to 58 billion of people. That is, the world economy increase leads to the increase of revenues in developing countries, which is accompanied by the increase of demand on energy resources.
- This defines decision searching to satisfy growing necessities in energy sources.

Listed trends and forecasts of energy complex development pave the way to the dialogue on actual problems deciding, collaboration and experience exchange on new technologies creation and implementation among world countries.

Methodology

In order to identify the dependence between infrastructure and world economy development let's refer to the table 1.

Table 1. Basic data for correlation analysis of connection between world production of energy sources and industrial production volumes in world economy, and ecological safety level of world economy in 1914-2012[1]

Year	Volume of world production of energy resources, bln tones of conventional energy sources (x)	Industrial production volume in world economy, bln tones of conventional products (y_1)	Ecological safety degree in world economy, conventional balls (y_2)
1913	0.31	1.41	0.90
1923	0.93	4.25	0.87
1933	1.42	6.53	0.85
1943	2.54	11.67	0.83
1953	3.96	18.20	0.81
1963	4.71	21.93	0.77
1973	6.85	31.73	0.70
1983	8.73	40.65	0.65
1993	10.34	78.07	0.61
2003	11.72	54.60	0.57
2013	15.65	72.40	0.52

Following the data of table 1 let's make up an equation of linear regress line function for linear connection behavior y_1 from x by using MathCad software, and get: b_1=3.73, b_0=2.14. This way we get the following equation of line regression: $\hat{y}_1(x)$= 2.14+3.73x.

Index b_1=3.73 means that with the rise of the volume of world production of energy sources to 1bln tones of conventional energy sources, the volume of industrial production in world economy increases to 3.73 bln tones of conventional products. Pearson coefficient for deduced model is r_{xy}=0.954.

This means, we may conclude that there exists a tight fit between world production energy sources and industrial production volumes in world economy.

Let's calculate the determination coefficient: $D=r^2_{xy}*100\%=95.4\%$. It follows that the increase of industrial production volume on 95.4% in world economy, is explained by the increase of the volume of world production of energy sources. Let's make an estimate of line regression model by means of mean approximation error, which for the deduced model makes up 6%. This suggests that the model is qualitative. Let's estimate the line regression model by means of Fisher's F-criterion. Adduce a null-hypothesis: H_0: b_1=0. $F=\frac{r^2}{1-r^2}*(n-2)=\frac{0.99^2}{1-0.99^2}*(11-2)=91.129$. Ftabl. (crit)=5.12. As far as Fobserv.>Ftabl., then the equation of regression is significant at the set level. This means that hypothesis H_0 appears to be false.

This way, in accordance with line regression equation we got, that is, with the increase of the world production volume of energy sources to 1 bln tones of conventional energy sources, the volume of industrial production in world economy increases on 3.73 bln tones of conventional production. Interdependence between analyzed conditions is strong and straight (rxy=0.954). Volume payments variation with the usage of electronic payment systems on 95.4% (D) is explained by variation of retail in Russian Federation.

Approximation error (6%) shows a god relation between estimated and factual data. As far as Fobserv.>Ftabl., the hypothesis H_0 about the accidental nature of identified dependence and statistic non-significance of equation parameters and correlation ratio dimensions, is meandered.

Counted parameters of line function to characterize dependence y_2 from x by means of MathCad, deduce: b_1=-0.04, b_0=1.18. By this means, deduce the following equation of regression: $\hat{y}_2(x)$=1.18-0.04x. Index b_1=-0.04 shows that with the increase of world production volume of energy sources of 1 bln tones of conventional resources ecological safety degree of world economy decreases on 0.04 of conventional balls. Correlation coefficient for deduced model is r_{xy}=0.936. It means, we may conclude, that a strong interdependency between the volume of world production of energy sources and the degree of ecological safety of world economy exists.

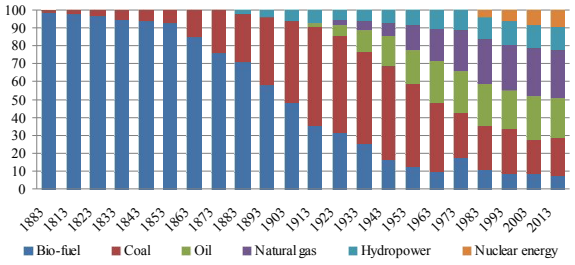
Count the determination coefficient: $D=r^2_{xy}*100\%=93.6\%$. By this means, the decrease of ecological safety degree of world economy on 93.6% is explained by the increase of world production volume of energy sources. Estimate the model of line regression by means of the mean approximation error, which, for deduced model makes up 8%. Thence, we may conclude that the model is qualitative. Estimate line regression model by means of Fisher's F-criterion. Suggest a null-hypothesis: H_0: b_1=0. $F=\frac{r^2}{1-r^2}*(n-2)=\frac{0.97^2}{1-0.99^2}7\ (11-2)=90.357$. Ftabl. (crit.)+5.12. As far as Fobs.>Ftabl., the equation of regression is significant at the set level. Thus, the hypothesis H_0 is false.

Thus, according to the deduced line regression equation, with the increase of the world production volume of energy sources to 1 bln tones of conventional energy sources, the ecological safety degree decreases by 0.04% of conventional balls. Dependency between considering conditions is strong and right (rxy=0.954). Payments volume variate with retail usage in Russian Federation.

The approximation error (8%) shows a close fit of estimated and factual data. As far as Fobs.>Ftabl., the hypothesis H_0 of the accidental nature of the identified dependency and statistic non-significance of equation parameters, correlation ratio dimensions is meandered.

Results

Energy supports civilization and it has activated wide economical changes, which modified the economy of the whole world for the recent 250 years. Consequently, there exist a tight fit between power complex and world economy development. The world economy history can be represented as the evolution of energy usage and a steady increase of energy consummation. New forms and energy sources and new technologies of this energy usage have already changed and are still continue changing the energy balance and widening an assortment of available energy sources in the world economy power complex structure. Picture 1 reflects dynamics of energy complex structure changing in 1883-2013.



Picture 1. Dynamics of power complex structure changing in 1883-2013 [1]

As we may see from drawing 1, the turning points in the history of power complex development, when under influence of technological development, quality changeovers to the new stages of power complex development have happened, can be set aside. So in 1883 in the structure of power complex, previously consisted exceptionally of biofuel and coal, appeared hydro power, encouraging the increase of factory production facilities all over the world. In 1913 in energy complex structure appeared oil, which attained wide usage in industry.

In 1923 in the structure of energy complex appeared the natural gas, which attained wide usage as a fuel and a product for chemical industry. In 1934 in structure of power complex appeared nuclear energy, which was accompanied by explosive industrial development. Consequently, development of power complex infrastructure encourages world economy development.

For the recent 100 years (from 1913 to 2013) world consumption of energy increased 50 times. The same times increased the volume of industrial production. For recent decade, growth rates of energy complex infrastructure and industrial development have increased especially quickly. This way, for 2003-2013 world energy consumption and industrial production volume have increased to 27% [2].

The structure of the world power complex has undergone substantial transformations. In 2013 the coal ratio made up 28.3%, which increased on 25.1% in comparison with year 2003. Renewable energy sources stake doubled from 0.6% to 1.1%. This is evidence of dynamic changes in the world economy. Yet in 2003 energy consumption was concentrated in developed world, which consumed almost two third of the world oil production.

Nowadays oil consumption is shared almost equally between developed and developing countries. In nearest decade we should expect a staged concentration of world oil consumption in developed countries in the wake of revenues, rising in these countries and in the wake of the build-up of industrial production volumes. Specified tendency testifies the stage decrease of differentiation in world economy development [3].

In 2003 the renewable energy sources were in the first instance, represented as the hydroelectric power. The hydroelectric power is still a dominating renewable energy source, and the recent decade is characterized as “renewable energy sources renaissance”. Nowadays renewable energy sources are a growing global business. In 2013 renewable power energy was estimated in 184 blns dollars. Led by wind power non-water energy sources, the ratio increased from 1.4% in 2003 to 4% in 2013.

Wind was and stays the most considerable factor of renewable energy sources growth (55% from the production of renewable energy sources).

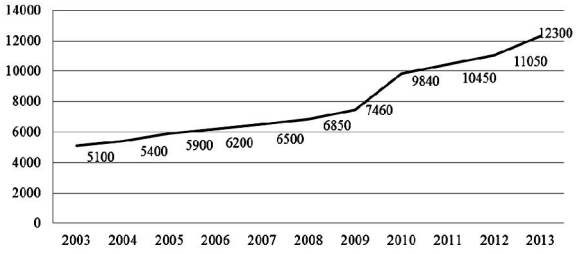
The third place is occupied by biological fuel (15% of renewable energy sources production).

Nuclear power supplies 12% of the energy world production. Until 2011 nuclear power considered to be highly competitive. After the accident at Japanese nuclear power plant “Fukushima”, the safety of nuclear power engineering was put into question. However, this doesn’t restrain definite countries with high demand on electricity growth, such as China and India, from volumes increasing of nuclear energy production [4].

For recent 250 years the oil became a dominating energy source in the process of staged switchover from coal. Meanwhile, natural gas became a global fuel. As the picture 2 shows, global trade with natural gas doubled since 2003 to 2013. By 2020 the increase in world trade with natural gas to more than 50% should be expected.

Long-term world market of natural gas was financed; many long-term contracts were made on it, which gave the necessary investments in expensive infrastructure, necessary for natural gas trade. Natural

gas will gain importance as a fuel in future. Today, natural gas makes up 21% of the world power complex.



Picture 2. Global trade with natural gas in 2003-2013, bln actual cubic feet [1]

There exists a sensible geographic diversity of natural gas production. Thus 47% of natural gas is produced at the Near East and only 10% in Asia Pacific Region. For recent thirty years natural gas consumption tripled and it may increase on 50% by 2035.

A reason for natural gas demand is a flexibility and multi-functionality of its usage. Natural gas trade is completed in all markets: B2B, B2C, B2G. The highest demand on natural gas is observed in OECD countries.

Conclusion

As a result of fulfilled observation there was brought to the light that energy complex infrastructure fulfils few tasks simultaneously in the world economy: economical, social, political and ecological. Economical role of energy complex infrastructure in the world economy development involves natural capacities extension of industrial enterprises, growth and development of power complex in world economy development involves labor market development at the expense of new work positions creation in energy and other industrial branches [6].

The political role of energy complex infrastructure in world economy development is in the decrease of development level differentiation of various countries at the expense of their provision with necessary energy sources for industrial production development [7].

Ecological role of the energy complex infrastructure in world economy development consists of provision of sufficiently high degree of ecological safety in various world countries upon condition of trend pickup of the world industrial production [8].

Outputs

In process of power complex infrastructure development the economical and mathematical problem of optimization is being solved, which includes the aim of industrial production trend pickup and is realized upon conditions of restriction, the necessity of reservation of sufficiently high grade of ecological safety in various countries of the world [9].

Mathematical model of power complex infrastructure development looks as follows:

$$\begin{cases} \sum_{i=1}^{n} p_i \to max \\ \sum_{i=1}^{n} u_i \to min \end{cases} \quad (1)$$

Where n – is the quantity of infrastructure objects of the world power complex;

p_i – is the volume of energy sources production of i-object in world power complex infrastructure;

u_i – is the ecological damage, caused be object i of the world power complex infrastructure.

As a part of the composed model of power complex infrastructure development, the balance of production development and necessary level of ecological safety maintenance in various countries of the world, is provided [10].

Thus, we may conclude that the role of power complex infrastructure in world economy development is in the provision of conditions for industrial production development and quality of life of various countries population increase at the cost of opportunity provision of more goods purchasing and full satisfaction of necessities in industrial goods.

Corresponding Author:
Dr. Akopova Elena Sergeevna
Rostov State Economic University
Large Garden, 69, Rostov-on-Don, 344007, Russia

References

1. Energy Vision 2013. Energy transitions: Past and Future. Date Views 20.05.2014 www.weforum.org/reports/energy-vision-2013-energy-transitions-past-and-future.
2. Popkova, E., S. Morkovina, E. Patsyuk, E. Panyavina and E. Popov, 2013. Marketing strategy of overcoming of lag in development of economic systems. World Applied Sciences Journal, 26(5): 591-595.
3. Popkova, E., E. Akopova, E. Alekhina, J. Dubova, J. Popova, I. Avdeeva and I. Proskurina, 2013. Methodology of development

of strategy of development of economic systems. World Applied Sciences Journal, 26(4): 489-493.
4. Volosatova, U., Shvagerus, P., Popkova, E. and I. Budanova, 2014. Conceptual Approach to Ecological Information Marketing System Formation at the Russian Market. World Applied Sciences Journal, 30(8) :1020-1023.
5. Dorgham, L.S., S.K. Hafez, H.E. Kamhawy and W.B. Hassan, 2014. Hassan Assessment of Initiation of Breastfeeding, Prevalence of Exclusive Breast Feeding and Their Predictors in Taif, KSA. Life Science Journal, 11(1): 1-9.
6. Ahmed, K. El Rajy, A.R. Goraya and U. Kausar, 2014. Mechanics of Bond Behaviour at the Joint of Normal Strength Concrete Intersecting Beam. Life Science Journal, 11(1): 41-49.
7. El-Sayed, H., A. Hassanein, R. Fawzy, M. Zahran, O. Mahmoud, Y. Yacoub and A. Moustafa. Impact of Different Preparation Methods on the In Vitro Quality of 8 Days Storage Platelet Concentrates. Life Science Journal, 11(1): 50-57.
8. Zhang, X., 2014. Panhysterectomy Resulting From a Residual Cesarean Scar Pregnancy after Dilatation and Curettage A Case Report. Life Science Journal, 11(1): 99-103.
9. Saad, M.H., J.Y. Tamboul and M. Yousef, 2014. Uranium content measurement in drinking water for Some region in Sudan using Laser Flourometry Technique. Life Science Journal, 11(1): 117-121.
10. Alzahrani, A.S., 2014. Security analysis of RFID based devices in educative environments. Life Science Journal, 11(1): 133-140.

7/11/2014