The competitiveness of the national economy: energy-related aspects

Eleonora Matuygina [1,2*], *Tatiana* Rumyantseva [1], and *Anastasiya* Klabukova [1]

[1]National Research Tomsk State University (NR TSU), 36 Lenin Ave., Tomsk, 634050, Russia
[2]Tomsk State University of Control Systems and Radioelectronics (TUSUR), 40 pr. Lenin, Tomsk, 634050, Russia

Abstract. The aim of the paper is to assess the competitiveness of national production in terms of its resources and energy supply. The authors present the dynamics of energy intensity of some countries and regions of the world and consider the relationship between the level of energy intensity and the competitiveness of national economies. Based on this relationship, countries are grouped depending on the type of the performance indicators of economies. Alternative energy is presented as a tool for improving efficiency of existing industries and for ensuring countries' position in the world market. The increase in the share of renewable energy in total consumption served as a basis for studying experience of various countries in regulating the development of alternative energy followed by a grouping of methods. The paper analyses both methods associated with the positioning of alternative energy and its incorporation into the existing structure and methods aimed at stimulating the development of alternative energy.

1 Introduction

The expanded reproduction of living conditions together with population growth requires the intensive involvement of various types of resources in the economic turnover. According to the UN report "Population and Vital Statistic Report", the world population reached 7.3 billion people in 2014, and the increase was 5.5% in 2018 (7.7 billion people) [1]. Over the same period, global GDP grew by 7.6% (78 944.49 and 84 929.51 trillion dollars, respectively) with an increase in energy consumption by 14.3% (12231 and 13978 Mtoe, respectively) [2]. Because of the predominant orientation of national economies on the use of traditional energy sources in the conditions of resource constraints, such dynamics encourages the search for new energy sources and optimization of the process of energy production and consumption. An additional justification is the negative impact of traditional energy on the environment (for example, in 2018, CO2 emissions from burning fossil fuels reached 33.1 Gt CO2, i.e. increased by 1.7% in comparison with 2017, and according to IEA (International Energy Agency), the energy sector accounted for almost two-thirds of emissions [3]).

* Corresponding author: emk512542@mail.ru

Russian researchers (Trifilov D.I., Sergeev N.N. and others [4,5]) as well as foreign researchers (Kraft J., Kraft A; L.Liu, T.Chen and Y.Yin and others [6, 7]) cover the issues of energy efficiency. Moreover, Mardani A., Zavadskas E.K., Streimikiene D., Juson A. and Khoshnoudi M.A.; Zhang X.P., Cheng X.M.,Yuan J.H. and Gao X.J. [8, 9] focus on the symbiosis of economic (energy) and environmental components of the development of society.

2 Data and results

Table 1 presents the energy intensity data of some countries and regions of the world.

Table 1. Energy intensity of GDP (MJ/$) [10].

Region / country	Year						
	2005	2007	2009	2010	2015	2025 (forecast)	2035 (forecast)
Russia	17.06	16.64	12.97	11.32	10.08	9.01	7.89
Canada	14.63	14.27	13.47	11.95	11.03	10.18	9.43
South Korea	13.43	13.27	10.31	8.55	7.76	7.14	9.28
USA	10.06	9.92	8.49	7.58	6.97	5.97	5.37
Australia and New Zealand	9.61	9.59	8.80	7.85	6.97	6.20	5.50
China	7.47	8.14	6.58	5.48	4.65	3.99	3.46
European Union	7.73	7.68	6.75	6.00	5.26	4.70	4.20
Japan	7.12	7.09	6.41	6.01	5.75	5.53	5.32
Mexico	7.03	6.85	6.78	6.16	5.58	4.97	4.44
Brazil	6.66	6.64	6.51	5.59	5.10	4.68	6.09
India	4.42	4.36	3.33	2.94	2.57	2.24	1.92

China has one of the lowest energy intensity indicators (4.65 MJ/$) and is one of the countries with the highest energy consumption, which is because of an unbalance between GDP growth rates and energy consumption (according to 2015 data, GDP growth of 6.9% was accompanied by an increase in energy consumption of only 1%). In the USA, the GDP growth of 2.9% was accompanied by a decrease of 1% in energy consumption [11, 12]. Let us analyze some countries and consider types of the performance indicators that have a direct impact on energy intensity (Table 2).

Table 2. Grouping of countries (according to data of 2007 – 2015 [12, 13]).

Country		
Unidirectional causality from GDP growth to energy consumption		**Bi-directional causality from GDP growth to energy consumption**
GDP exceeds energy consumption	*GDP lags behind energy consumption*	*GDP↑, energy consumption↓***
Russia (125.10/105.51[a])	Iran (115.28/123.04)	Japan (116.04/84.40)
Canada (127.41/101.44)	United Arab Emirates (144.94/154.00)	USA (126.07/93.84)
Brazil (135.37/125.42)	Algeria (143.66/145.95)	Spain (109.67/82.64)

[a] growth rate of GDP (%)/ growth rate of energy consumption (%)

** the reverse trend is not observed in any country in the world

We understand that the competitiveness of the national economy is based on the dynamics of its development and the welfare of the population [14] and on the internal conditions for maintaining effectiveness of national exports [15] (and production in general). Therefore, we can note that energy intensity management is an important tool for creating competitive advantages, which is reinforced by actions to increase supply of energy resources.

Figures 1-2 show a comparison between the level of energy consumption (energy intensity of GDP) and the competitiveness rating for groups of countries.

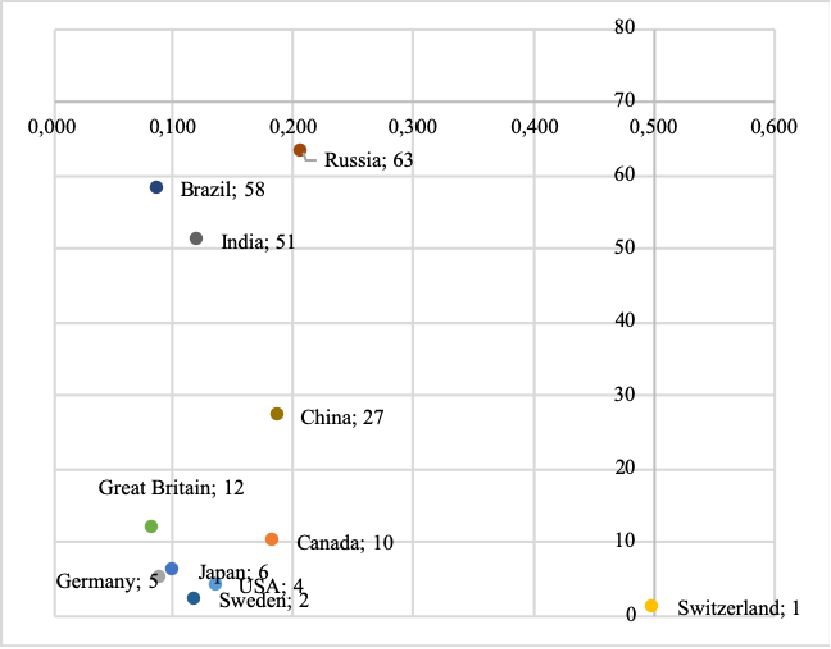

Fig.1. Dynamics of energy intensity and competitiveness (2010).

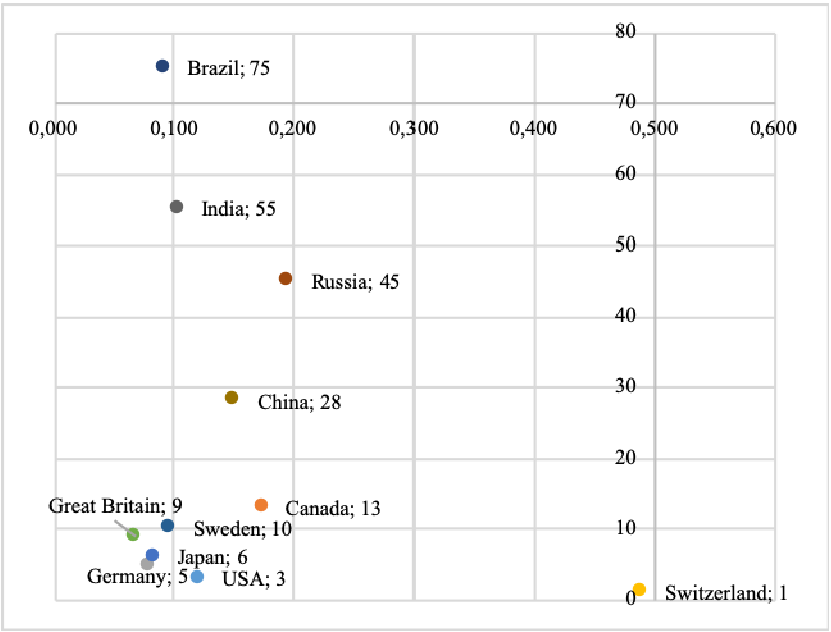

Fig.2. Dynamics of energy intensity and competitiveness (2015).

In addition, we should note that in certain countries, an increase in the competitiveness ranking could be accompanied by a decrease in energy intensity. Thus, the US shift in the ranking from the 4th to 3rd place was accompanied by a decrease in the energy intensity of GDP from 0.136 to 0.121 kg of oil equivalent per US$. Russia's shift from the 63rd to 45th was accompanied by a decrease in energy intensity from 0.207 to 0.109 kg of oil equivalent per US$. However, the opposite changes are also possible, which is proved by the example of Canada, Sweden, India, China, etc. We should also note that China is a market leader in the production of solar modules. In 2017, China and Taiwan accounted for about 70% of the global volume of solar panels [16].

Traditional energy resource constraints are both a threat to the sustainable development of the international community and an incentive to acquire new competitive advantages. We mean alternative energy, which on the one hand, is a tool for maintaining or increasing the competitiveness of existing industries, and on the other hand, is an independent direction of cross-country competition (in terms of technology development).

According to the Global Energy Statistical Yearbook (2018), the share of renewable sources in total consumption grew by 1% to an average level of 26% in the world (USA - 17.5%, Germany - 36.0%, Switzerland - less than 10%, Japan – 17.5%, Sweden - 55.3%, Russia - 17.2%, China -26.3%, etc.) [17].

Table 3 presents the methods for the alternative energy development used in different countries of the world [18].

Table 3. Incentive methods

Purpose	Method	Content
Positioning of alternative energy, integration into the current structure of consumption	The Public Utility Regulatory Policies Act (USA, 1978)	Reduced consumption of fossil resources by stimulating the use of alternative energy.
	The Renewable Energy Sources Act (Germany, 1991)	The obligation of network operators to purchase energy from enterprises using renewable energy sources.

	The 10th five-year Plan of Economic and Social Development of the People's Republic of China	Determination of the need to use renewable energy sources and the goals and trends of alternative energy development.
Stimulating the production and the development of alternative energy	Green Tariffs (USA)	Increasing tariffs for alternative energy by 10-20%; contracts between the state and private companies for the purchase of alternative energy.
	Compensation Plan (USA)	The purchase price is set at the level of real costs; all additional costs for companies are compensated.
Stimulating the production and the development of alternative energy	Quota model (European countries – Great Britain, Sweden, Austria, Belgium, etc.)	The state allocated quotas ("green certificates") for the production of alternative energy. If the level of produced energy exceeded the quota, the company was eligible to sell the surplus to other companies at market prices. If the level of produced energy was less than the quota, the company bought the missing volume from other companies (with excess) or paid a fine.
	Golden Sun Program 2009 (People's Republic of China)	Subsidies up to 70% of the production cost to manufacturers of solar panels were established.

3 Conclusion

Thus, we can consider the level of energy intensity not only as one of the criteria for evaluating competitiveness of the national economy, but also as a tool for its formation / strengthening. Despite the existence of a significant number of factors determining the competitiveness of the national economy, we can perceive energy management as the basic factor that ensures national production as a whole.

References

1. United Nations, Population and Vital Statistic Report, Statistical Papers Series A, LXXI (ST/ESA/SER.A/265), (2019)
2. Knoema Eterprises, [https://knoema.ru/atlas/%D0%92%D0%B5%D1%81%D1%8C-%D0%BC%D0%B8%D1%80/%D0%92%D0%92%D0%9F].
3. Global Energy and CO2 Status Report, [https://www.iea.org/geco/emissions/].
4. D.I. Trifilov, Energy efficiency as one of the elements of competitiveness of the Russian economy, Modern competition, **4**, 96, (2012).
5. N.N. Sergeev, Theoretical aspects of energy saving and energy efficiency of industrial enterprises, Vestnik of Astrakhan State Technical University. Series: Economics, **1,** 29-36, (2013).
6. J. Kraft, A. Kraft, Journal of Energy and Development, 3.401–403 (1978)
7. L. Liu, T. Chen, Y. Yin, Energia Procedia. 88. 224–229 (2016)
8. X.P. Zhang, X.M. Cheng, J.H. Yuan, X.J. Gao, EnergyPolicy, 39(2). 644-650 (2011)

9. A. Mardani, E.K. Zavadskas, D. Streimikiene, A. Juson, M. Khoshnoudi, Renewable & Sustainable Energy Reviews, 70. 1298-1322 (2017)
10. Samarina V.P. Innovative economy: prospects for development and improvement, 5(15), 133-138, (2016)
11. The World Bank, GDP, [https://data.worldbank.org/indicator/NY.GDP.MKTP.CD]
12. Total energy consumption [https://yearbook.enerdata.ru/total-energy/world-consumption-statistics.html]
13. World GDP Ranking, [http://svspb.net/danmark/vvp-stran.php]
14. I.S. Bondarenko, Economy of Industry, **3** (38) (2007).
15. M.V. Loskutova, Tomsk State University Journal, **2** (2009).
16. The largest manufacturers of solar modules in 2017, [http://renen.ru/the-largest-manufacturers-of-solar-modules-in-2017]
17. Share of renewables in electricity [https://yearbook.enerdata.net/renewables/renewable-in-electricity-production-share.html]
18. O.I. Malikova, M.A. Zlatnikova Public administration. E-journal: **17**, 5- 30 (2019).