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ENERGY SECURITY AND ENERGY CONSUMPTION IN BULGARIA

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Abstract: The paper defines the concept of energy security and outlines the role of energy security for national economies. The energy sector in Bulgaria has been analyzed as well as the energy dependence from foreign energy supplies that secure/ensure internal energy consumption.

The paper gives information for the dynamics and trends of development of energy consumption in Bulgaria for the period 1990–2013. The prognoses for the future energy consumption trends are presented. The method of trend extrapolation of energy consumption development is used.

The energy balance of Bulgaria is analyzed regarding the usage of local and imported primary energy sources (coal, petrol, natural gas, nuclear energy, renewable energy sources) for ensuring final domestic energy consumption (for all industrial sectors and households).

A detailed analysis of each of the primary energy sources used for electricity production is elaborated; the advantages and disadvantages of each of them have been explained.

Special attention has been paid to the engagement of Bulgaria concerning the implementation of Europe 2020 strategy and the future energy policy of the country that includes not only enhancing energy security but also increasing the share of renewable energy sources in final energy consumption, building of a new energy infrastructure, development of a highly competitive energy market, finding the right balance between the interests of energy consumers and energy producers and suppliers.

The article also points out the dependence of major energy projects upon the changes in political situation.

Key words: Energy security, energy consumption, energy sources, energy statistics

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INTRODUCTION

The Bulgarian energy agenda is determined by deepening of the link between the Bulgarian and the European Union energy policy.

Energy security (Commission on Sustainable Development (2007)) of Bulgaria is a multi-facet problem that includes the country's provision of traditional and renewable energy sources as well as measures for enhancing energy efficiency in all industrial sectors. National energy security should be analyzed in parallel with the EU energy security policy. Energy markets liberalization, transparency and efficiency are important prerequisites for the achievement of national energy security. Diversification of energy sources (traditional and renewable) and diversification of the routes via which energy sources (mainly natural gas and petrol) are delivered are also important elements of national energy security.

The energy security policy of Bulgaria is integrated (Energy Efficiency Agency (2010)) in the “Climate change – Energy” pack policy measures.³ The Bulgarian energy policy is currently under restructuring that is inspired by the clear strive to energy independence, efficiency and transparency. The development of contemporary national energy policy of Bulgaria will have a major impact on tomorrow's national and regional (SEE) energy security and energy markets.

Energy system is a “cardiovascular” system of any economy: being well-provided-for electricity, petrol and natural gas economy it has one of the major prerequisites of sustainable economic growth. Economic and social welfare of any state depends on many factors, among which is safe and reliable energy supply. That is why energy security is an issue in both economic and national security.

The Bulgarian energy sector is a key factor for the economic development of the country. On the average, for the last ten years exports of electricity and imports of energy sources account annually for 12% and 21%, respectively, of the total trade turnover of Bulgaria. For the last ten years, every 4th public procurement deal has been concluded in the energy sector as well. In one particular year – 2008, Bulgaria started energy projects with a monetary value equal to the European funding budgeted for Bulgaria for the whole EU programming period 2007–2013.

Different external factors exert an impact on energy security of Bulgaria as well, and among them are global climate change and the EU binding objectives for CO₂

³ The concept “energy policy” is often used in theory as well as in the acts of EU institutions. In Part I of the Treaty for Establishing of the European Community energy is set as one of the major Community activities. This is important because two of the Communities – The European Coal and Steel Community and EURATOM are entirely devoted to energy aspects. Proceeding from the ideas and principles of the EU legislation, it can be assumed that the EU energy policy represents a complex of policy measures that have been undertaken at the EU level, which are aimed at implementing actions that will result in certain long term effects for the energy sector at the EU level and at the national level for the EU member states.

emissions reduction, global trends of reduction of energy intensity of the economy and enhancing of energy efficiency, global trends of increasing the usage of Renewable Energy Sources (RES) in the total energy mix, the economic crisis impact on the energy sector, political risks resulting from internal and external geopolitical interests.

The objective of the article is to make an analysis of energy security and energy consumption of Bulgaria.

ENERGY SECURITY OF BULGARIA – STATE OF THE ART AND PROSPECTS FOR DEVELOPMENT

Energy security is important for contemporary economy because the uneven geographic distribution of energy sources in different parts of the world makes certain countries vulnerable to energy supply security risks. Energy security enhancement is the only decision for these countries, though the basic elements that should be focused vary from country to country; nevertheless, energy security involves diversification of energy sources and the routes via which they are imported in any energy dependent state enhancing energy efficiency of the local economy, effective usage of the available local energy sources, flexibility of the energy system, balancing the different interests existing on any energy market, diversification of the total energy mix (via stimulation of both renewable and traditional energy sources usage in the final gross energy production and consumption).

Having in mind the key role of energy security for national security of Bulgaria, our country has to solve several basic problems that have roots in the energy field and hinder the overall economic development of Bulgaria. Seven years after its accession to the EU Bulgaria cannot decrease the high level of energy dependence from Russia and cannot increase the overall energy efficiency of the economy to reach an acceptable EU level. Local energy sources are not sufficient to satisfy internal energy consumption.

National energy balances depict most clearly the situation in the energy field of any country. Bulgaria is strongly dependent on imports of crude oil, natural gas and high quality coal, while the only significant local energy sources are low calorie lignite and brown coal and hydro energy. In 2012, the primary energy production in Bulgaria satisfied approximately half of the total internal energy consumption this mostly resulting from the contribution of solid fuels and nuclear energy. A clear trend could be followed in the last twenty years: nearly 2/3 of the energy sources that have been further transformed have been used for electricity production and heating. Approximately 30% of the total energy sources that have been transformed are directed to oil refineries and the rest of it is transformed by briquettes compressing factories, blast and coking companies. Final energy, produced as a

result of primary energy sources transformation, amounts to approximately 60% of the primary energy input.

In 2012, the predominant part of the energy available for final consumption was used by transport (31.7%) being followed by industry (28.5%) and households (26.5%). The structure of the final energy consumption of energy sources by type of source outlines oil products as the leading energy source followed by electricity and natural gas. Slowly, but certainly, consumption of energy generated by renewable energy sources has increased over the last years and decades. In 1990, renewable energy had accounted for only 1% of the final energy consumption in Bulgaria; in 2012 it contributed with 12% of the final energy consumption. Solid fuels have the smallest percentage in the final energy consumption – 4.8% of the final energy consumption is formed by solid fuels consumption in 2012.

Coal is one of few energy sources which is naturally available in Bulgaria. Large deposits of low calorie lignite coal have some undisputable advantages as low costs of extraction, low transportation costs (for the territorial proximity of the coal deposits to their basic consumers – the thermo electric power plants “Maritza Iztok 2”, “ContourGlobal Maritza Iztok 3” and “AIS Galabovo”). The advantages of this type of energy source make it reliable and independent from external geopolitical factors. The total production of coal in Bulgaria in 2012 was 33.4 million tons, where lignite and brown coal prevailed. “Maritza – Iztok Coal Mines” Single-member PLC is the basic producer contributing with 96.2% of the total coal production in Bulgaria. Internal consumption of black and anthracitic coal is totally satisfied by imports that come mainly from Ukraine and Russia. Black and anthracitic coal imports are processed mainly by the thermo electric power plant “Varna” that is the second largest thermo electric power plant on the Balkan Peninsula. This plan is expected to bring closer full modernization in the recent years that will result in black coal reduction. In Bulgaria 97.4% of coals (no matter of their type) is used for production of electricity and thermal energy, 1.4% of coal is used for production of briquettes, 0.7% is used by the thermo electric power stations for their own energy needs and 0.5% is used by households for homes heating.

Consumption of petroleum is satisfied by petroleum imports because local Bulgarian petrol deposits are rather humble and local petroleum extraction is low (only 23.5 thousand tons in 2012). Petroleum imports come predominantly from Russia (which is the main exporter), but in the last five years there are some separate import deals for petroleum imports from Ukraine, Georgia and Kazakhstan. Notwithstanding these import deals, they refer to rather low import quantities that do not affect the fact of practically full energy dependence on the petroleum imports from Russia. In 2012, petroleum imports in Bulgaria were 5.7 million tons. “Lukoil Neftochim Bourgas” JSK is the main Bulgarian refinery as well as the biggest one on the Balkan Peninsula. Taking into account the fact that the Russian company “Lukoil Group” is the owner of the refinery and since its establishment

the company has been adjusted to process the Russian petroleum of the “Ural” type, reduction of the Russian petroleum imports dependence is hardly likely to occur for Bulgaria.

Bulgaria is one of the biggest petrol exporters in South East Europe. In 2012, Bulgarian production of petrol products is 6.0 million tons, diesel fuel holds the largest portion of petrol products production, which is followed by gasoline and steam generators fuel. The consumption of these petrol products is distributed almost equally between the internal and the exports markets. A positive trend of rising exports of these commodities could be followed and they represent a constantly growing share in the total exports of Bulgaria. Basic export markets for Bulgarian petrol products are Central European countries, the Balkan Peninsula countries, the USA and Singapore. Despite Bulgaria is one of the major petroleum processing countries in the region, nearly 50% of its local consumption is satisfied by imports (mainly of diesel and gasoline) and distribution which is done by large foreign companies distribution networks in Bulgaria.

Bulgaria is heavily dependent on natural gas imports. Natural gas imports satisfy almost all internal demand of natural gas. Russia is the only importer of this energy source, and the gas itself is imported via the only existing import route passing through Ukraine, Moldova and Romania. In 2012, natural gas consumption in Bulgaria was 2.7 bln. cubic meters, natural gas imports were 2.5 bln. cubic meters and local extraction was 389 mln. cubic meters.

Problems of natural gas market in Bulgaria are connected both with consumption and supplies. Gas consumption follows a steady downsizing trend in the last years. Industry and energy plants are the main consumers of natural gas in Bulgaria, but their activities are shrinking in the last years, while household gasification has rather low levels in Bulgaria (1.5% of homes in Bulgaria has gas supply) compared to the EU average (55%) (“Energy strategy of Republic of Bulgaria till 2020” (2011)). Moreover, the share of Bulgarian households that use natural gas is growing rather slowly that is an additional constraint to the market of this energy source.

Another important problem of Bulgarian gas sector is the high dependence of Bulgarian economy on Russian gas supplies. The combination of lack of alternative sources and routes for gas delivery and the limited quantities of gas consumption in Bulgaria results in higher gas prices for final consumers in Bulgaria. This fact reduces the export competitiveness of local industrial companies. The strong vulnerability of Bulgaria to the security of gas supplies became evident during the gas crisis from the beginning of 2009 and was the main reason for the actions that have been taken later for building of inter-system connections between the Bulgarian natural gas transportation system and the gas systems of the neighboring EU countries (Greece and Romania) as well as for the participation of Bulgaria in

building of the South gas corridor that is supposed to supply natural gas for the region that comes from the Caspian region and Near East. Even though, these actions are not enough to avert future crisis situations concerning the security of gas supplies to Bulgaria.

Gross consumption of electricity in Bulgaria was 47.3 terawatt-hours in 2012. Thermoelectric power stations have a predominant share of 43.4% (20.5 terawatt-hours) in the total electricity production. The nuclear power station “Kozlodui” contributes with 33.4% (15.8 terawatt-hours) of the total electricity production in Bulgaria and its share in the total national electricity production has remained approximately unchanged before and after stopping of its four old reactors (reactors 1-4). Renewable energy sources generate nearly 11% (5.2 terawatt-hours) of the total electricity production of Bulgaria and nearly 2/3 of renewable energy comes from hydroelectric power stations. Bulgaria exports electricity to neighboring Balkan countries: in 2012, the exports of electricity amounted to 8.3 terawatt-hours (17.6% of the total energy production) to Greece, Macedonia, Serbia and Turkey, while prospective export markets for Bulgarian electricity are Kosovo and Italy.

Production of renewable energy is a basic energy priority of Bulgaria in the recent years. According to the “Europe 2020” strategy Bulgaria has the commitment to achieve an important national target: renewable energy should secure 16% of gross final energy consumption in Bulgaria till 2020. Hydroelectric power stations have a leading role in renewable energy production in Bulgaria and new priorities of national energy policy result in a considerable and steady growth of the share of renewable energy produced in wind and photo-voltaic power stations.

Electricity generated by wind power stations amounted to 1.2 terawatt-hours in 2012 what was 23.4% of gross renewable electricity production. Photovoltaic power stations generated 0.8 terawatt-hours, what was equal to 15.4% of gross renewable electricity production in Bulgaria for 2012. In order to achieve the objective of “Europe 2020” Strategy Bulgaria applies the national energy policy that stimulates the installation of renewable energy power capacities by guaranteeing buying up of renewable energy from producers at high preferential prices for a period of 20 years as well as priority accession of renewable energy of all types that has been produced all over the country to the national system for energy distribution. The result of these policy measures has been a strong development of the renewable energy sector in Bulgaria and the investment interest that had even created an investment balloon on the renewable energy market. Bulgaria overfulfilled the 2020 target for eight years before the set deadline – the share of renewable energy in gross final energy consumption reached 16.3% in 2012. The country, however, was in a difficulty to provide sufficient financial resources for buying up renewable energy, what resulted in higher electricity prices for final consumers that paid the bill. To solve this problem a number of legislative changes have been introduced that decreased investors interest to the renewable energy

sector in Bulgaria. The legislative changes include reduction of preferential tariffs for buying up renewable energy and reduction of the period of their validity, setting of these tariffs and validity periods after the completion of power stations construction works, the right of the regulating government institution to change the tariffs once per year and the introduction of a special fee for connection to the national system for energy distribution.

With a view to the key role of the energy sector for the Bulgarian economy, the energy policy aims of enhancing national energy security, raising the share of renewable energy in the final energy consumption, development of a competitive national energy market, satisfying energy needs at national level while balancing between energy producers and consumers interests. An adequate energy infrastructure is a key factor for the achievement of these goals for it is the “cardiovascular system” of the economy. Proper maintenance and development of national energy infrastructure is an important factor for sustainable development of national economy and economic and social welfare of the nation. The forecasts for increase in energy consumption in Bulgaria in the forthcoming years make the need for improving the existing national energy infrastructure as well as extending and enlarging it, what is a real issue and a step for improving national energy security.

As a whole, carrying out of energy sector projects depends on both their expedience and the concrete political situation and geopolitical conventionalities hiding considerable risks for their implementation. For example, carrying out of most of the biggest national energy projects has been postponed or prolonged for decades and in the meanwhile some of them have dropped out of the national priorities projects lists. For example, the construction of a second nuclear power station (“Belene” nuclear power station) in Bulgaria is an issue that had suffered many twists in the past decades and finally after many funds had been invested, in February 2013 the government in Bulgaria officially froze the construction works on the project and stopped working on it.

As a participating country in the project for building of the so-called South gas corridor that represents a priority project for the EU, Bulgaria participates actively in almost all projects for supply of the Caspian and Near East gas to Europe. Concerning this corridor, the key geographic location of the country makes it a leading transit route for natural gas to the other EU countries. Carrying out of these projects, however, met serious problems arising from market conditions, different political interests of the participating countries and inconsecutiveness in the participating governments’ actions (mostly the Bulgarian government) concerning the energy projects. The basic transit routes for gas supply in which Bulgaria has participated are the projects “South Stream”, Trans-Adriatic Pipeline (TAP) and the construction of inter-connecting pipelines between the gas pipeline systems of Bulgaria and its neighboring countries (Greece, Turkey, Romania and Serbia). The Project “South Stream” was stopped on 1 December 2014 when the Russian

President Vladimir Putin announced during his visit to Ankara, Turkey, that Russia would invest in a new gas pipeline through Turkey and Greece that would replace the “South Stream” which would be stopped. The construction of these pipelines will result in diversification of the routes for gas supplies that will reduce the dependence of Bulgaria on Russian imports. At this stage, only the inter-connecting pipeline with Romania is under construction and will soon be finished, but this pipeline offers limited possibilities for real diversification and alternative route for gas supply. The construction of inter-connecting pipeline between Bulgaria and Serbia is postponed for the ambiguity on how the project will be financed, because the interconnecting pipeline between Bulgaria and Turkey is still under negotiations and for the Bulgaria–Greece interconnecting pipeline it is quite clear that financing is totally missing.

The Irish company “Petroceltic” that has bought “Merlous Resources Sarl” in the fall of 2012 has undertaken an investigation on the possibilities for extraction of natural gas in the Black Sea Bulgarian territorial waters. Currently, it exploits the “Kavarna” and “Kaliakra” gas deposits and extracts 729.9 thousand cubic meters of natural gas daily. It is expected that till 2015 another gas deposit (“Kavarna-east”) will start operation, thus extending the production of this company up to 850 thousand cubic meters of natural gas daily. This will be enough to satisfy just about 10% of domestic demand for natural gas in Bulgaria.

Another perspective for enhancing national energy independence is the project for construction of the 7th reactor (and potentially of one more 8th reactor) of the “Kozlodui” nuclear power station. The basic advantage of this project is the existing supporting infrastructure. Thus, it is obvious that the costs for construction of an entirely new nuclear power station will be higher than the enlargement of the existing one. Notwithstanding, at this stage the future of this project is unclear as well.

STUDY OF THE TRENDS OF DEVELOPMENT OF ENERGY CONSUMPTION IN BULGARIA

Trends of development are considered to be basic components of development when studying the dynamics of economic phenomena and processes. The trend of development is a result of the action of considerable, important and permanent factors and reasons that determine the direction of development of a certain economic phenomenon. Studies of trends of development contribute to the analysis in the following aspects:

- From a descriptive analysis viewpoint such studies clearly show the regularities of the development of the phenomenon;
- From a prognostic analysis viewpoint it helps to prognosticate the future levels of energy consumption in the country.

Internal gross energy consumption

Internal gross energy consumption includes the entire energy consumption of a certain country, regardless of the type of energy sources that have been consumed (Eurostat 2013). It is measured in thousand tons of oil equivalent and its diagram of development has been presented on Fig.1.

From the diagram of development it could be noticed that the development of internal gross energy consumption in the last 23 years follows a clear downsizing trend. A number of factors determine this development such as the reduction of the population of Bulgaria in the last 23 years, increasing of the energy efficient technologies application both in industry and in the living houses, the closedown or restructuring of many energy consuming companies, etc. Moreover, quite logically it is evident that in periods of economic crises total energy consumption decreases and in periods of economic growth it grows up.

Fig. 1. Dynamics of the internal gross energy consumption for the period 1990–2012 measured in thousand tons of oil equivalent



Except for the simple visual tracing of the trends of development, statistical methods such as hypothesis testing can be applied in the energy field. Different tests are known in theory that help finding out whether a trend of development⁴ is available for a given dynamic row. Autocorrelation coefficients of first order⁵ (Dimitrov, 2005; Mishev and Goev 2010) are among the most commonly used tests. It is considered that when dynamic rows contain a trend of development they are

⁴A dynamic row of data is “a row of primary or secondary data, ordered chronologically in time, that reflect the changes in a certain phenomenon in time”.

⁵“Autocorrelation is the correlation between the consecutive meanings of a certain statistical data row”. “Autocorrelation coefficient of first order can successfully be used as a criteria for testing the presence of a trend”.

autocorrelated, e.g. each member of the row is correlated and depending on the previous member/s of the same dynamic row.

Velichkova (Velichkova, 1981, p.7) describes how to find autocorrelation coefficient of first order, using the formula:

$$r_1 = \frac{\sum_{i=2}^N Y_i Y_{i-1} - \frac{1}{N-1} \sum_{i=1}^{N-1} Y_i \sum_{i=2}^N Y_i}{\sqrt{\left[\sum_{i=1}^{N-1} Y_i^2 - \frac{1}{N-1} \left(\sum_{i=1}^{N-1} Y_i \right)^2 \right] \left[\sum_{i=2}^N Y_i^2 - \frac{1}{N-1} \left(\sum_{i=2}^N Y_i \right)^2 \right]}}$$

where: r_1 is autocorrelation coefficient of first order,

Y_i are the values of the dynamic row,

Y_{i-1} are the lagging values of the dynamic row,

and N is the length of the dynamic row.

To perform the test, two hypotheses should be defined: a zero hypothesis (H_0) and an alternative hypothesis (H_1). According to the zero hypothesis there is no autocorrelation in the dynamic row that we examine, e.g. the autocorrelation coefficient is not statistically significant and there is no development trend. According to the alternative hypothesis, the autocorrelation coefficient is statistically significant and there is a development trend. The risk of mistake is 5% ($\alpha 0,05$).

Table 1 presents the results of the calculation of the autocorrelation coefficients and their levels of significance. In this case, the autocorrelation coefficient of first order is equal to $r_1 = 0.471$ and its level of significance is less than 0.05. According to the methodologies defined by Velichkova (Velichkova, 1981, pp. 71–74) and Mishev and Goev (Mishev and Goev, 2010, p. 45), this means that we can assume the hypothesis for presence of trend of development. In the particular case that we study, with a probability of 0.95% we can assume that the gross internal energy consumption in Bulgaria for the last two decades follows a trend of development.

Table 1. Autocorrelation coefficients of gross domestic energy consumption (Mishev and Goev (2010))

Lag	Autocorrelation coefficients	Standard errors	Test of Ljung – Box		
			Empirical characteristics	Degrees of freedom	Level of significance
1	0.471	0.196	5.789	1	0.016
2	0.286	0.191	8.034	2	0.018
3	0.251	0.187	9.849	3	0.020
4	0.097	0.182	10.135	4	0.038
5	0.215	0.177	11.607	5	0.041
6	0.157	0.172	12.440	6	0.053

Modeling of the trend

Modeling of trends of development results in specifying the analytical type of the function, where the phenomenon has been studied depending on time, where “Y” is the energy consumption in Bulgaria, “t” is artificial variable for time, and ε_t is accidental component in the model.

To determine the trend of development 11 different econometric models are used (linear and non-linear), where the trend of development is described through the model that has greater explanatory power.⁶ The results have been presented in Table 2.⁷

Table 2. Results from the 11 econometric models constructed to describe the trend of development of gross internal energy consumption in the country

Models	Characteristics of the models				
	Coefficient of determination	F em	Degree of freedom 1	Degree of freedom 2	Level of significance
$Y_t = \beta_0 + \beta_1 t + \varepsilon_t$	0.524	23.080	1	21	0.000
$Y_t = \beta_0 + \beta_1 \ln t + \varepsilon_t$	0.694	47.693	1	21	0.000
$Y_t = \beta_0 + \frac{\beta_1}{t} + \varepsilon_t$	0.714	52.339	1	21	0.000
$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t$	0.630	17.022	2	20	0.000
$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3 + \varepsilon_t$	0.679	13.424	3	19	0.000
$Y_t = \beta_0 \beta_1^t + \varepsilon_t$	0.547	25.349	1	21	0.000
$Y_t = \beta_1 t^{\beta_2} + \varepsilon_t$	0.690	46.731	1	21	0.000
$Y_t = e^{\beta_0 + \beta_1 t} + \varepsilon_t$	0.664	41.453	1	21	0.000
$Y_t = e^{\beta_0 \cdot \beta_1^t} + \varepsilon_t$	0.547	25.349	1	21	0.000
$Y_t = \beta_0 e^{\beta_1 t} + \varepsilon_t$	0.547	25.349	1	21	0.000
$Y_t = 1 / (1 / u + \beta_0 \beta_1^t) + \varepsilon_t$	0.547	25.349	1	21	0.000

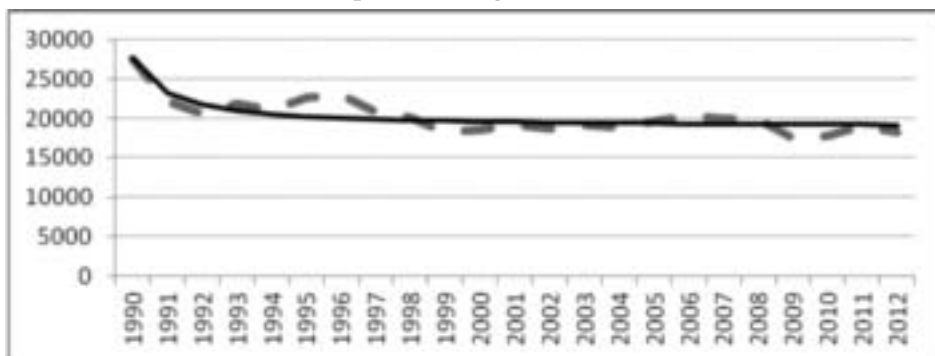
The results of the competitive models that have been used show that the hyperbola model () could be assumed as the best model that has the following shape after it has been evaluated with the parameters:

⁶ From statistical point of view, the most appropriate model is the model that has the highest coefficient of determination (R Square).

⁷ For studying of the trends of development it is possible to use different econometric models, among which the most appropriate will be the model that will have the highest coefficient of determination. 11 models are used for the current research that is suitable for this types of researches.

Graphically the trend of development can be presented as a hyperbola (Figure 2.)

Fig. 2. Dynamics and trend of development of gross internal energy consumption in Bulgaria, 1990–2012.



As Figure 2 depicts, the trend of development (the dense incessant line) for the last two decades is downsizing. In this case, it is specific that gross internal energy consumption has been gradually reducing, while at the same time the speed of this reduction is gradually slowing down, so that mathematically the trend of development is slowly coming near to its asymptote which is about 18-19 kilotons of oil equivalent.

The econometric model that has been chosen could be assumed as good, because it explains 71% of the changes in the gross internal energy consumption in the country.

In order to properly analyze the dynamics of gross internal energy consumption in the country it is necessary to trace out the dynamics of energy consumption of the different types of energy that have been consumed in the country for the respective period. These types of energy sources are coal, petroleum products, natural gas, nuclear energy, renewable energy sources (Boneva and Atanasov, 2013) (Table 3).

Table 3. Data (used in the analysis) for energy consumption in Bulgaria by type of energy source, thousands of oil equivalent

Year	Gross energy consumption	Coal	Petroleum	Natural gas	Nuclear energy	Renewable energy sources
1990	27,649.7	8,716.6	9,094.7	5,395.7	3,782.9	333.9
1991	22,255.5	7,697.5	6,006.7	4,617.0	3,400.9	350.8
1992	20,651.8	7,556.2	5,476.6	4,066.6	2,979.9	340.0
1993	21,955.0	8,137.3	6,085.1	3,802.3	3,604.4	316.5
1994	21,161.5	7,572.5	5,521.8	3,820.2	3,959.6	293.7
1995	22,689.4	7,621.3	5,628.0	4,584.4	4,458.5	411.0
1996	23,000.4	7,731.2	5,470.3	4,676.2	4,670.4	491.0
1997	20,781.6	7,835.9	4,468.5	3,699.7	4,585.6	476.5
1998	20,213.1	7,499.6	4,850.3	3,129.1	4,365.9	678.2
1999	18,287.4	6,488.7	4,527.4	2,686.2	4,086.4	658.1
2000	18,522.6	6,432.9	4,068.2	2,931.4	4,699.4	776.4
2001	19,295.7	7,244.2	4,157.6	2,738.1	5,058.0	692.3
2002	18,694.6	6,650.5	4,114.8	2,402.3	5,232.7	828.0
2003	19,296.2	7,326.7	4,498.5	2,499.6	4,473.7	942.1
2004	18,940.5	7,220.5	4,370.4	2,492.7	4,351.5	980.0
2005	19,754.1	6,895.0	4,724.4	2,804.1	4,826.0	1,098.2
2006	20,398.8	6,965.7	4,956.3	2,900.6	5,042.3	1,140.5
2007	20,036.9	7,863.9	4,720.6	3,010.4	3,797.6	961.6
2008	19,926.5	7,551.1	4,767.2	2,914.2	4,088.3	1,062.2
2009	17,504.1	6,400.6	4,303.4	2,160.7	3,958.4	1,111.3
2010	17,769.8	6,886.8	3,887.8	2,300.4	3,956.1	1,456.6
2011	19,089.9	8,105.9	3,669.2	2,630.3	4,230.3	1,362.6
2012	18,233.3	6,931.4	3,837.0	2,451.2	4,094.2	1,627.2

Prognosis for energy consumption in Bulgaria in the forthcoming years until 2020

As it has been already mentioned modeling of trends of development could be used both to describe the objective laws governing the developments in energy consumption in Bulgaria in the years that have already passed as well as to make prognosis for the forthcoming years (Fig. 3, Table 4).

Figure 3. Prognostic values of gross internal energy consumption in Bulgaria until 2020

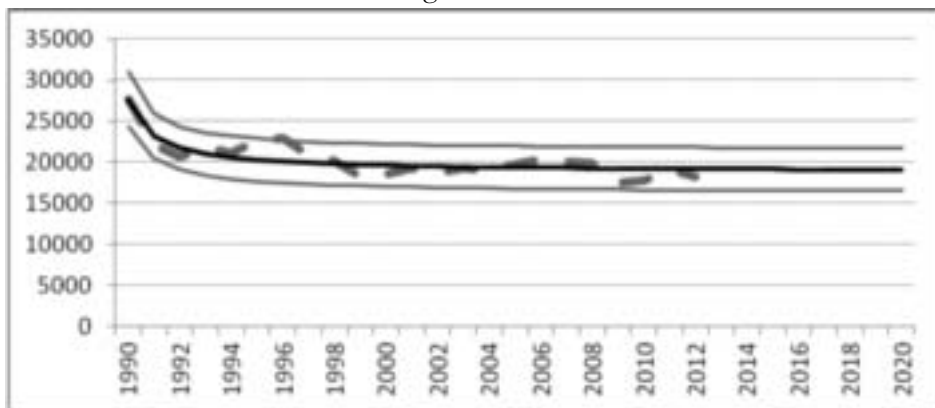


Table 4. Prognostic values of gross internal energy consumption in Bulgaria until 2020, kilotons of oil equivalent

Years	Expected gross internal energy consumption	Lower limit	Upper limit
2013	19,200	16,595	21,805
2014	19,185	16,580	21,791
2015	19,172	16,565	21,778
2016	19,159	16,552	21,766
2017	19,148	16,540	21,755
2018	19,137	16,529	21,744
2019	19,126	16,519	21,734
2020	19,117	16,509	21,725

The presumption that has been assumed here is that energy consumption in Bulgaria in the forthcoming years until 2020 will follow the same patterns of development as in the period that has been analyzed (1990–2012). The econometric models that have been used as well as all definitions of the concepts used in the statistical analysis are explained in detail by Velichkova, 1981 and Mishev and Goev, 2010.

To receive a realistic and reliable statistical prognosis, the following key issues should be taken into account:

- The choice of appropriate functions for modeling of trends of development. The functions have been chosen in the previous stage of the research, where 11 mutually competitive econometric models have been used;

- The received parameters can be accepted as stable ones, because we do not observe different trends of development in dynamic rows that have been examined for the different time periods;
- It can be assumed that in the forthcoming years the trends in energy consumption in the country will be relatively unchanged since no major technology or economic changes are expected as a whole;
- The modeled trends will be extrapolated until 2020 and will provide a prognosis for the average expected values of energy consumption in the country;
- Confidence intervals have been calculated for the prognosis, which show the limits within which the values of energy consumption can fluctuate in the forthcoming years, with a probability of 0.95.

On the basis of the prognosis that has been developed, if we presume that the trend of development of gross internal energy consumption in the country will not change in the forthcoming years, it is highly probable that in 2020 it will be no less than 16, 509 and no more than 21, 725 thousand oil equivalent.

Table 5. Prognostic values of expected consumption of energy in Bulgaria until 2020 by type of primary energy source, in thousands of oil equivalent.

Year	Coal	Petroleum	Natural gas	Nuclear energy	Renewable energy sources
2013	7,359	4,326	2,644	3,725	1,588
2014	7,399	4,318	2,715	3,576	1,673
2015	7,435	4,310	2,800	3,419	1,761
2016	7,468	4,303	2,900	3,257	1,850
2017	7,494	4,297	3,015	3,090	1,942
2018	7,515	4,291	3,144	2,919	2,037
2019	7,527	4,285	3,288	2,745	2,134
2020	7,529	4,280	3,446	2,568	2,233

In spite of the fact that energy consumption in Bulgaria depends on different factors, an attempt to make a prognosis for the energy consumption in Bulgaria in the forthcoming years has been done with the use of econometric models. On the basis of the research it can be assumed that if energy consumption trends that have been observed in the last two decades in Bulgaria remain unchanged for the years to come, the expected total energy consumption in 2020 will be 19, 117 thousand tons of oil equivalent. As far as energy consumption by type of energy is concerned, a considerable rise in the energy consumption of renewable energy could be expected, while other types of energy sources consumption will slightly decrease or will remain relatively unchanged.

CONCLUSIONS FROM THE STATISTICAL ANALYSIS

The study and prognosis of gross internal energy consumption in the country is a complex process that is, however, crucial for the proper management of national energy policy and the smooth functioning of all economic processes in the country as a whole. The study has traced out the main trends of development of total energy consumption and prognosticated the expected energy consumption in the country until 2020. The total energy consumption in Bulgaria shows a steady downsizing trend for the last two decades and it is quite logical that this trend will be kept unchanged. It is important to mention that the pace of this reduction is slowing down and it is quite probable that in the future, energy consumption will retain at a relatively steady level.

In support of the downsizing trend of gross internal energy consumption in Bulgaria in the forthcoming years we can point out the following facts:

1. Population is one of the major groups of energy consumers in Bulgaria. According to the demographic prognosis of the National Statistical Institute, the number of population will decline in the following years, so the expected energy consumption of the population will decline as well.
2. Companies represent the second major group of energy consumers in Bulgaria. They have constantly increased their energy efficiency in Bulgaria in the last years and this tendency is expected to continue, so the expected energy consumption of companies is expected to decline.
3. Finally, the high explanatory power of the econometric models that have been presented (the high coefficients of determination) make the prognoses that have proved to be highly reliable.

CONCLUSION

The policy of Bulgaria in the field of energy is directed mainly towards increasing of energy security increasing the share of renewable energy in the final energy consumption, the development of a competitive energy market, satisfaction of the population and industry needs of energy and finding the proper balance between the interests of consumers and producers. The achievement of these objectives could be made through building of a new energy infrastructure that will contribute to energy security of the country. Carrying out of new strategic energy projects for Bulgaria (in the field of nuclear energy and South Stream) will bring to a reduction energy dependence of the country.

The analysis and the prognosis of the gross internal energy consumption in Bulgaria are crucial for the management and implementation of the nation's energy policy.

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Svetla BONEVA

ENERGETSKA BEZBEDNOST I POTROŠNJA U BUGARSKOJ

Apstrakt. Rad definiše koncept energetske bezbednosti i naglašava njen značaj za nacionalne ekonomije. Analizira se energetske sektor Bugarske kao i energetska zavisnost od stranih energetske zaliha koje obezbeđuju/osiguravaju unutrašnju potrošnju energije.

Rad daje informacije o dinamici energetske potrošnje Bugarske u period od 1999 do 2013. Takođe su predstavljene i prognoze za buduću energetske potrošnju, uz primenu odgovarajuće metodologije.

Energetska ravnoteža Bugarske je analizirana u pogledu upotrebe domaćih i uvoznih primarnih energetske izvora (ugalj, benzin, prirodni gas, nuklearnu energiju, obnovljive energetske izvore) za obezbeđenje celokupne domaće energetske potrošnje (za sve industrijske sektore i domaćinstva).

Analiziraju se primarni energetske izvori koji se koriste za proizvodnju električne energije, kao i njihove prednosti i nedostaci.

Posebna pažnja je posvećena angažovanju Bugarske u pogledu sprovođenja strategije Evropa 2020 kao i njena buduća energetske politika koja uključuje ne samo poboljšanje energetske bezbednosti nego i povećanje udela obnovljivih energetske izvora u ukupnoj energetske potrošnji, izgradnja nove energetske infrastructure, razvoj visoko konkurentnog energetske tržišta, pronalaženje adekvatne ravnoteže između interesa potrošača i proizvođača energetske proizvoda.

Rad ističe i zavisnost velikih energetske projekata od promena političke situacije.

Ključne reči: energetske bezbednost, potrošnja energije, energetske izvori, energetske statistika.

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