EMPIRICAL EVALUATION OF GDP ENERGY INTENSITY REDUCTION IN BELARUS AS RESPONSE TO THE GLOBAL CRISIS

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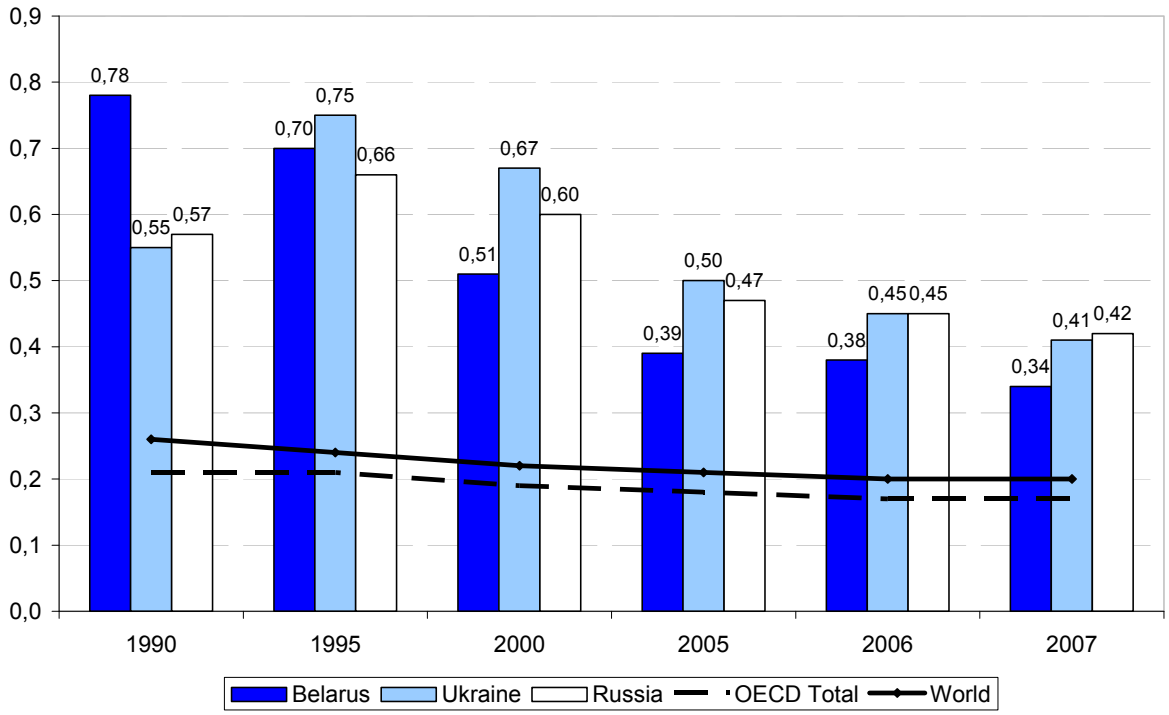
1. INTRODUCTION

The progress in the sphere of energy efficiency achieved during the Belarusian independence period is obvious and seems to be the best among the CIS countries. This is recognized by all experts including the international ones [1]. By the moment of the independence declared the Belarusian economy was one of the most energy wasteful in the world with energy intensity (TPES/GDP PPP) coming in 1990 to 0,78 toe per thousand 2000 USD [2]. During the period of 1990 – 2007 due to the system state policy encouraging the energy saving the Belarusian GDP energy intensity decreased by 2.3 times to 0,34 toe per thousand 2000 USD (the GDP of 2007 exceeding the GDP of 1990 in 1.5 times). Yet the achieved energy consumption level is 2 times as higher than the average of the OECD and 1.7 times higher than the world average (Figure 1). Comparatively low rate of the energy efficiency of the Belarusian economy and high rate of the power dependence makes the issue of the energy price and supply terms one of the most significant factors of the national economic security.

Fig. 1. Dynamics of TPES/GDP PPP (toe per thousand 2000 US dollars) in Belarus, Ukraine and Russia in comparison with OECD and World average



As response to the global crisis the Government plans [3] reduction of the Belarus' GDP energy intensity in comparison with 2005 levels: by 31% in 2010, 50% in 2015, 60% in 2020.

To illustrate the significance of the goal set, below are given the comparative data of the GDP energy intensity in the Central European states and other regions of the world for 2005 [1,2] (Table 1).

Table 1. GDP energy intensity in 2005

Indicator	World	EU-27	Central Europe			Belarus
			Hungary	Czech Republic	Poland	
GDP energy intensity, toe*/USD 1000 GDP PPP in prices of 2000	0.21	0.16	0.18	0.24	0.20	0.39
GDP energy-intensity of Belarus to a corresponding energy-intensity value ratio, times	1.86	2.44	2.17	1.62	1.95	1.0
GDP energy-intensity of Belarus reduced value to reach the corresponding value, %	46.1	59.0	53.8	38.5	48.7	0.0

**toe – tons of oil equivalent*

As shown in the Table 1, the GDP energy intensity of Belarus was over that of the world average level in 2005 by 1.86, and of the European one – by 2.44. For all that to achieve the world average meaning (of 2005 level) the GDP energy intensity of Belarus is to be reduced by 46.1% of the 2005 level, and to reach the European average level – by 59.0%. So, the Concept target [3] drop in the Belarus' GDP energy intensity within 31% by 2010 will result in the energy intensity value of 0.27 toe per USD 1000 of GDP at PPP in prices of 2000, that exceeding the average values of the Central European states in 2005, still being comparable to them. The envisaged by the Concept objectives of the Belarus' GDP energy intensity reduction by 50% (year 2015) and by 60% (year 2020), as compared to the level of 2005, will enable our country to reach the world and European average values of the energy intensity respectively in 2015 and 2020. Taking into consideration that the world average drop in the GDP energy intensity for a 5-year period is from -5% to -10% (calculated by data for 1990 – 2005), and that of the European average – from 0% to -12% (calculated by data for 1990 – 2005), the goals set in the Concept being achieved will let Belarus join the "club" of the leading states according to the energy efficiency. Yet to achieve this level, there should be revealed the main reasons and economic preconditions for the still low energy efficiency of Belarusian economy disregarding the 10 years of active energy-saving policy and the fact of the respective economic priorities in the energy efficiency policy being put.

It is significant that Belarus started its energy saving programmes realization with extremely low level of energy efficiency – 0.78 toe per USD 1000 of the GDP PPP in prices of 2000. By total primary energy supply per a unit of the GDP at the PPP in 1990 Belarus was surpassed by only 8 countries of the world: Bosnia and Herzegovina (1.24), Uzbekistan (1.23), Turkmenistan (0.97), Mongolia (0.93), Nigeria (0.88), Qatar (0.82), Kazakhstan (079), and Bahrain (079). So, in 1990 Belarus was among the ten of the most energy consuming economies of the world, leaving behind such countries as Zambia, Kenya, Mozambique, and North Korea. In general, the energy intensity of the former USSR states in 1990 surpassed the world average level by 2.3 times. After the transformational slide in the economies this gap in the energy efficiency increased in 1995 to 2.9 times. Beside the obvious conspicuous consumption of energy in the Soviet economy, the main reason for the increased demand of the energy resources was the structural disproportions in the USSR economy accounting for the undeveloped service sector as compared to the material-production sphere. The Table 2 gives the GDP structure in the world, developed countries, USSR and BSSR (Belarusian Soviet Socialist Republic) in 1990 [4, 5].

Table 2. GDP structure in 1990, %

Indicator	World	Developed countries	USSR	BSSR	Developing countries
Services	61.4	65.3	33.7	29.2	49.6
Industry	33.1	32.0	46.8	47.2	35.6
Agriculture	5.5	2.7	19.5	23.6	14.8

According to the Table 2, the former USSR countries were the most industrialized countries in the world, at least, by the relative indices. In the BSSR the ratio of industry and agriculture was even greater, against the services, in the GDP than that in the USSR on average. So, the main goal of this research is evaluate contribution of structural and technological effects to the energy intensity of GDP reduction in Belarus during 1995-2006.

2. METHODOLOGY

The decomposition approach is used [6]. The energy intensity of GDP is decomposed as follow:

$$e = \frac{TEC}{GDP} = \sum_{i=1}^{n} \frac{TEC_i}{GDP} = \sum_{i=1}^{n} \frac{TEC_i}{VA_i} \cdot \frac{VA_i}{GDP} = \sum_{i=1}^{n} e_i \cdot \delta_i \qquad (1)$$

here: e – energy intensity of GDP; TEC – total energy consumption; GDP – GDP; i – summation index to possess the value from 1 to n; n – number of branches (sectors) of economy; TEC_i – total energy consumption by the sector i; VA_i – value added in the sector i; e_i – energy intensity of the value added in the sector i; δ_i – share of the value added of the sector i in GDP.

Fixing structure (δ_i) or technological (e_i) parameter at the value of the base year (1995) and changing the unfixed parameter according its actual dynamics the appropriate effects are possible to calculate.

To estimate and analyze the respective values variation with time, we'll introduce the index *t,* acquiring the values from 0 – reference year to *m* – number of the year following the reference one. With account of the signs taken from (1) we'll get the following expression to calculate the actual total consumption of energy in the year *t*:

$$TEC^t = GDP^t \cdot \sum_{i=1}^{n} e_i^t \cdot \delta_i^t \qquad (2)$$

The next indicators are to the place:

HEC^t – total energy consumption in the *t*-year on condition that the economic structure and energy intensity of the respective economic sectors remain at the level of the reference year:

$$HEC^t = GDP^t \cdot \sum_{i=1}^{n} e_i^0 \cdot \delta_i^0 \qquad (3)$$

HEC^t_S – total energy consumption in the *t*-year on condition that the economic structure remains at the level of the reference year, while the energy intensity of the respective economic sectors is actual:

$$HEC_S^t = GDP^t \cdot \sum_{i=1}^{n} e_i^t \cdot \delta_i^0 \qquad (4)$$

HEC^t_E – total energy consumption in the *t*-year on condition that the economic structure is actual while the energy intensity of the respective economic sectors remains at the level of the reference year:

$$HEC_E^t = GDP^t \cdot \sum_{i=1}^{n} e_i^0 \cdot \delta_i^t \qquad (5)$$

The indicators (3) – (5) introduced for analysis enable to evaluate the volume of energy consumption at different (reference and actual) values of the economic structure, energy intensity and to calculate the corresponding effects. In general, the following balance equation can be derived:

$$\Delta_{\sum}^t = \Delta_S^t + \Delta_E^t + \Delta_{SE}^t \qquad (6)$$

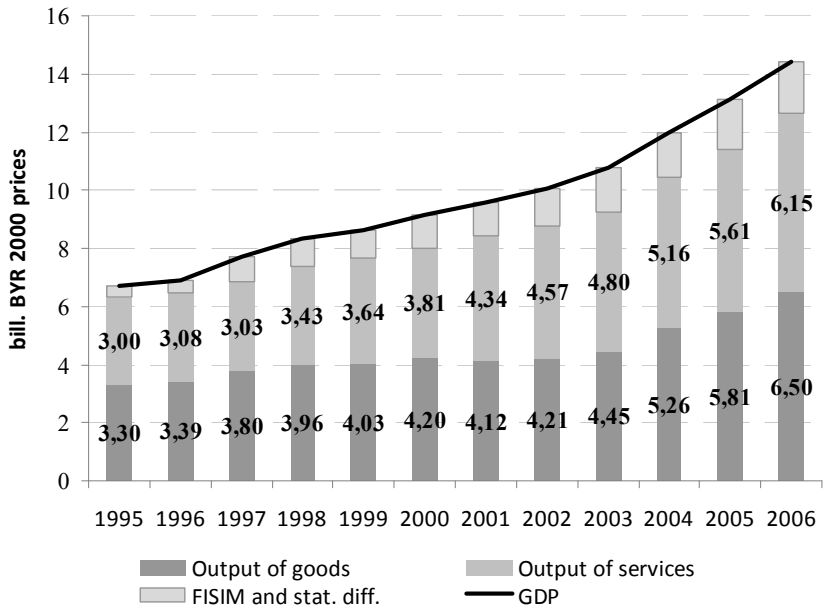
where $\Delta_{\sum}^t$ – an ***additive*** (total) effect – energy saving caused by the economic structure and energy intensity of the technologies change ($\Delta_{\sum}^t = HEC^t - TEC^t$); Δ_S^t – a ***structural*** effect – energy saving caused by the economic structure change ($\Delta_S^t = HEC_S^t - TEC^t$); Δ_E^t – a ***technological*** effect – energy saving caused by the energy intensity of the technological change ($\Delta_E^t = HEC_E^t - TEC^t$); Δ_{SE}^t – a ***synergetic*** effect – energy saving caused by combined structural and technological effects ($\Delta_{SE}^t = GDP^t \cdot \sum_{i=1}^{n} \Delta e_i \cdot \Delta\delta_i = GDP^t \cdot \sum_{i=1}^{n} \left(e_i^t - e_i^0\right) \cdot \left(\delta_i^t - \delta_i^0\right)$).

The worked out calculation procedure enables to disaggregate the economy to any number of sectors required by the analysis. Unfortunately, the energy statistics in the Republic of Belarus is restrained as for the data open publication, also it doesn't give the volumes of the total energy consumption per economic sectors. In this connection, to test the developed methodology, the IEA statistical data (energy balance) [2] and the data of the Belarusian state statistics committee (Belstat) [4] (as for the GDP and added values per economic sectors) have been used. Accounting for the fact that the IEA and Belstat grouping of the sectors being not identical, two sectors were decided to be singled out: 1) goods output; 2) services output. Such an approach enables, first, to smooth out the possible statistical discrepancy caused by differing requirements of the IEA and Belstat to the

information submitted, and, second, enables to show the contribution of the structural and technological effects to the Belarus' GDP energy intensity reduction in 1995 – 2006.

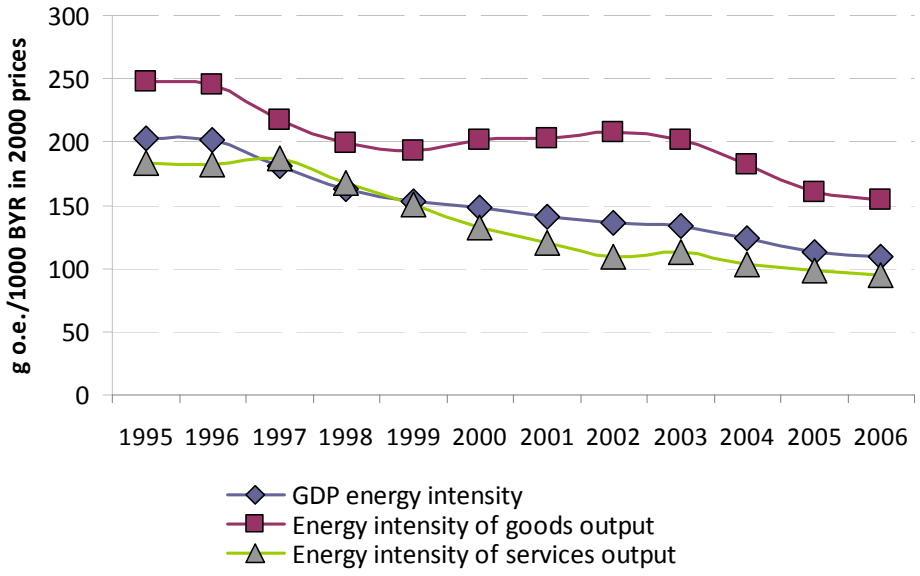
The GDP dynamics in market prices of 2000, gross added value made in the goods and services sectors in reference prices of 2000, as well as the net transfers and statistical discrepancy in prices of 2000 used to calculate the values (3) – (5) are shown in the Fig.2.

Fig. 2. Belarus' GDP in 1995 – 2006 in prices of 2000



The data on the gross added value energy intensity in the goods and services output, as well as the GDP energy intensity used for the calculations are given in the Fig. 3. and based on the Belarusian statistical methodology of branches classification. It should be noted that for comparability purposes the data on the total energy consumption given as an energy balance, according to the IEA, viewed through the economic sectors have been grouped as following: output of goods – industry, energy conversion sector, agriculture, non-energy-production use (except for the transport and services sector); output of services – transport, commercial and social services, household use, not distributed by groups, non-energy-production use (transport and services sphere).

Fig.3. Energy intensity of the GDP, goods and services output in Belarus in 1995 – 2006 in prices of 2000



Values calculated by formulae (3) – (6) are given in the Table 3.

Table 3. Calculated values of the energy saving caused by the economic structure changes and energy intensity of the technologies drop (reference year – 1995)

Indicator	2000		2005		2006	
	mln. toe	%	mln. toe	%	mln. toe	%
Δ^t_{Σ} – additive effect	9,17	100,0	21,28	100,0	24,30	100,0
Δ^t_{S} – structural effect	1,65	18,0	2,24	10,6	2,10	8,6
Δ^t_{E} – technological effect	7,04	76,7	17,69	83,1	20,77	85,5
Δ^t_{SE} – synergetic effect	0,48	5,3	1,34	6,3	1,42	5,9

It is important to mention that the methodology of the energy intensity of GDP decomposition proposed in [7] gives possibility to allocate the synergetic effect of the energy saving between structural and technological effects.

The share of services in Belarus' GDP is about 50% that less than in EU (70,7%) or world average (67,8%). So, the main factor to meet the Belarus' targets of energy efficiency is promotion of structural changes in the economy.

The statistical data [2, 5] analysis of the OECD countries (Iceland excluded for the reason of the climate) shows that the service industries share in the GDP varies from 55.4% in Norway (with the GDP energy intensity of 0.183 toe per USD 1000 at PPP) to 83.4% in Luxemburg (0.168). For instance, for Canada this relation is 66.3% and 0.276; for Denmark – 74.0% and 0.112; for Sweden – 70.6% and 0.186; Finland – 65.8% and 0.228.

So, at the given level of the economic development for Belarus to achieve the energy efficiency of the developed states the macroeconomic programming of the GDP energy intensity decrease is required combined with the strategy of the economic structural reforms. For that purpose it would be appropriate to intensify the structural component of the Belarusian economic policy.

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3. RESULTS

The goal of the energy efficiency improvement in Belarus should be considered in the context of two constituents of a single strategy implementation:

1) priority increase of the service industries share (as compared with that of the material-production one) in the GDP that will result in the reduced material and energy consumption of the economy as the financial, logistic, information and other services are far less energy-intensive than the machine-building, metallurgical or petrochemical industries. It should be emphasized that overall reduction in GDP energy intensity due to the increased share of the service industries in the GDP takes place even if the energy intensity of the technologies in the productive sphere remains at the initial level. So, the structure effect of the GDP energy intensity reduction (growth) is related to the saving (excessive consumption) of the energy resources as to the reference period and is caused purely by the economic structure change;

2) increase of the energy producers and consumers energy intensity of the technologies (technological inside of the production), that enabling the development of the industrial (material) production with the GDP energy cost per 1 ruble (dollar) of the added value reduction. In this case the GDP energy intensity is reduced due to the energy intensity of the production (output volume under the given energy consumption) growth. So, the technological effect of the GDP energy intensity reduction (growth) is related to the saving (excessive consumption) of the energy resources as to the reference period and is caused purely by the energy intensity of the technologies applied in the production process change.

Performed calculations have shown that in 2006 compared with 1995 savings of energy is achieved 8.6% by changes in the structure of economy and 85.5% by increase in energy efficiency of technologies. The effect of the energy saving program in Belarus during 1995-2006 has reached 21.3 million toe (total primary energy supply was 26,6 mio toe in 2006). Lack of structural component of energy-saving policy has been revealed. In order to achieve energy efficiency of developed countries the Republic of Belarus needs to ensure macroeconomic programming of decreasing GDP energy intensity together with the strategy of structural economic reforms.

4. REFERENCES

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