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Acta oeconomica et informatica 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2010, s. 29–32

ECOLOGICAL CONSTITUENT OF BIOFUEL USE: ECONOMIC ASPECT EKONOMICKÉ HLADISKO EKOLOGICKEJ ZLOŽKY VYUŽITIA BIOPALÍV

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The state of ecology in Ukraine and world and the impact of emissions from the use of mineral and biological types of fuel on the environment are briefly analysed in the given article. Comparisons are carried out and some conclusions concerning the state of bioenergy development and its influence on the environment are made.

Key words: bioenergy, raw biomaterial, biomass, renewed energy sources, greenhouse gases, emission of greenhouse gases

Global processes taking place in the modern world spur us to take a fresh look at and appraise the situation in the social domain, economy, and especially in ecology connected with continuous changes and transformations, to search challenging mechanisms of the state administration to manage these processes as well as new alternative energy sources.

Material and methods

The policy of gas emission reduction made by all industries of economy and formation of appropriate legislation are main obligations of Ukraine within the Scope Convention of UNO and Kyoto Protocol (Kyoto..., 1997). It anticipates comprehending in the brand new way current strategies of developing sectors of energy, transport, industry, rural, dwelling and municipal economies in Ukraine in order to minimize harmful impact of further economic development on the climate. All the more, the developed countries plan to reduce the emission of carbon by 80 % till 2050. (It will make possible to double the decrease of general emission of carbon in the air all over the world).

Hence, we must limit the use of fossil fuel to the level on which the world natural environment is capable to manage the emission. In the future, one should not pay attention to supply of all fuel, but to the amount, which can be utilized without serious damage to ecosystems serving as guards of our future.

Basic principles of reducing volumes of anthropogenic emission and increasing absorption of greenhouse gases are the following:

- sustainable economic development of Ukraine;
- formation of stimulant and favourable environment for business activities focused on the application of ecologically effective technologies and high-water marks aimed at reduction of anthropogenic emission and increase of greenhouse gas absorption;
- development and fulfilment of the state policy and measures, specified in the article 2 of the Kyoto Protocol according to the national regulations;
- stimulation of energy complex development based on bioenergy, transport, municipal economy, resource saving production, house building and corresponding services, improvement of the ecological situation and life level in Ukraine;

- ensuring economic attractiveness of investments focused on the increase of ecological efficiency and reduction of the emission of greenhouse gases.

The Agro-Industrial Complex (AIC) of Ukraine takes a leading place in this system at the present-day development. Traditional approaches to the AIC as a producer only of food and raw material for vital functions of a man do not engulf all the spectrum of problems. Nowadays it is not enough to provide the production of necessary amount of products for the society, these products ought to meet the international standards of quality, the major components of which are ecological constituents of all that is made and consumed, including production and consumption of the biological types of fuel as one of the factors of ensuring ecologically safe environment (Agro-Industrial..., 2009).

According to the analysis of research results and publications, a number of problems have not been solved either by scientists or practical workers. The problems are as follows: methodological fundamentals of development of a new sector of economy; providing of equivalence of profit gained from the production of raw biomaterial and biofuel; organization of production of these types of products by cooperatives and integrated associations; transition to the production of machinery as major biofuel consumers.

It is economically expedient to outline, conduct research on concrete objectives and substantiate their practical decision under the real conditions of Ukraine. The objectives are as follows: meeting the needs in energy resources and decline of power dependence through the use of raw biomaterial as one of major problems of the society on the modern stage of its development should be solved and grounded by both research and practice; providing of growth and not decline of the food production in the process of increasing volumes of raw biomaterial for the biofuel production; substantiating the effective economic relations of producers of biofuel and raw biomaterial.

The forecasted reduction of natural energy sources and strengthening of ecological requirements impartially induce the developed countries to involve additional alternative non-traditional energy sources. The most favourable solution of the problem has become a search for and use of renewed energy sources, among which the most popular are energy sources of biological origin, or biofuel: biodiesel, bioethanol, biogas.

Science and practice of the recent years have been heading for research and practical application of renewed energy sources, accumulated by a living substance by means of photosynthesis, utilization of the closed cycle of exchange of energy consumption and recreation.

In accordance with the theory of F. Keene about 'net product' and 'added value' of S. Podolynsky, who proved that all of the solar energy accumulating on the Earth through labour as an absolute added value is created exactly in agriculture and wood industry. However, in practice added value as an economic display of the accumulated energy on the initial stage is developed in agriculture, and further its lion's share is produced in other industries of the agro-industrial complex. According to the calculations of scientists, added value developed in the AIC is distributed approximately in this way: agriculture – 15–18 %; processing industry – 25–32 %; trade – 60–50 %.

Exactly in this connection of distributing of the added value agriculture as a branch of the national economy is indigenously lagging behind industry and trade, which in turn requires a scientific approach in decision making in the process of management. It is possible to solve this old problem, namely the improvement of rural areas and increase in profitability of agriculture in the development of market of raw biomaterial and biofuel that is practised on a large scale in many countries of the world.

Considering the Ukrainian alternative component of this problem, the use of renewed energy sources along with the solar, wind, water, geothermal energy is a strategic point of development of the country's economy, especially its agro-industrial complex. A number of assignments should be carried out by the state: ensuring energy safety and decline of dependence on the import of energy sources; sustainable development of agricultural production; creation of new workplaces in rural areas; increase of the state funding and investments to agriculture; and improvement of the environment.

Recent research have persuaded that it is high time to satisfy public needs in energy sources by means of renewed energy sources as alternative to the present-day carbohydrates. Biomass takes a prior place in Ukraine with its rich and varied flora. In this connection scientists must focus on the use of agricultural crops, i.e. biomass of plants having high energy content, which will form considerable advantages over extractive carbohydrates. Their use will facilitate the preservation of natural resources and their rational use an improvement of the environment.

Energy attractive crops of the European soil-climatic area to which Ukraine belongs are the following: one-year crops with high content of sugar and starch (sugar beet, cereals, corn, potato, Jerusalem potato, sorghum), which can be utilized for the industrial production of bioethanol; oil-yielding crops (rape seed, sunflower, soy beans, oil-bearing flax) oil and biodiesel are made from them; grassy perennials (sugar cane, site-specific hybrid of sorrel, millet, Pennsylvania mallow, etc). Science and world practice have proved that it is possible to make ethanol and biodiesel from biomass of agricultural and wood origin, which gradually, at first as additives to the traditional fuel, will substitute for extractive carbohydrates.

After joining of Ukraine to the Directives of 2003/30/EU and taking into account the land potential and necessity of solving a problem of dependence on the import of energy sources we can outline a real possibility to make considerable amount of biofuel, obtaining considerable economic benefit and not to break the level of the food safety.

A separate part of research of economic efficiency of the biofuel production is presented in the following calculations. There is a calculation of providing population with food according to the norms of consumption and necessity in sowing areas. The method of Derzhkomstat of Ukraine was taken as the basis of calculations, namely: it is necessary to involve 0.5–0.6 hectares of farm land in the agricultural production to provide one person with enriched ration.

- $S_{\pi, \epsilon} = 50\,000\,000 \times 0.55$ hectares = 27 500 000 hectares of farm land
- Or $27\,500\,000 \times 0.778 = 21\,395\,000$ hectares of plough-land
- All of plough-land in Ukraine – 32 500 000 hectares
- Plough-land is free of the food providing
- $S_{\beta io} = S_{\epsilon} - S_{\pi, \epsilon} = 32\,500\,000 - 21\,395\,000 = 11\,105\,000$ hectares
- S_{ϵ} – is general area of plough-land in Ukraine
- $S_{\pi, \epsilon}$ – is area which provides the level of the food safety in Ukraine
- $S_{\beta io}$ – is area for growing of raw biomaterial

Formula of calculation of production cost of 1 ton of bioethanol:

$$B_{et} = L_{\epsilon} \times K_{\epsilon} + T_{\rho} \times K_{\epsilon} + 3n - B_{\epsilon}$$

Where:

B_{em} – cost of production of 1 ton of bioethanol

L_{ϵ} – price of raw material

Table a Calculation of competitiveness of bioethanol and biodiesel

	Sugar beet (5)	Molasses (6)	Corn (7)	Wheat (8)	Rape seed (9)	Soy beans (10)
Price of 1 ton of raw material (UAH) (1)	210	700	650	700	2 100	1 500
Charges of raw material on 1 ton of oil, on 1 ton of bioethanol (t) (2)	12.5	4.46	3.1	3.57	2.69	10.0
Transport charges + cost of processing (UAH/t) (3)	2 455	2 300	2 600	2 500	1 120	811
Cost of production of bioethanol and biodiesel after minus of cost of marketing oil cake and grain stillage (waste) (UAH/t) (4)	4 100	3 500	3 233	3 450	6 355	7 100

Tabuľka a Výpočet konkurencieschopnosti bioetanolu a biodízelu

(1) cena 1 tony surového materiálu, (2) náklady na 1 tonu oleja, 1 tonu bioetanolu, (3) prepravné náklady + cena spracovania, (4) náklady na produkciu bioetanolu a biodízelu po odrátní nákladov na marketing pokrútín a výpalkov (odpadu), (5) repa cukrová, (6) melasa, (7) obilie, (8) krmná pšenica, (9) semená repky olejnej, (10) sója

Kc – amount of raw material
 Tp – transport charges
 $3n$ – expenses on processing on a bioethanol
 $B\bar{b}$ – cost of grain stillage marketing

Formula of calculation of production cost of 1 ton of biodiesel:

$$B\beta\delta = \text{Lc} \times Kc + Tp \times Kc + 3r'n \times Kc + 3r'r'n - B\bar{m}$$

Where:

$B\beta\delta$ – cost of production a biodiesel
 Lc – price of raw material
 Kc – amount of raw material
 Tp – transport charges
 $E'n$ – expenses on processing of oil
 $E'n$ – expenses on processing for biodiesel
 Bm – a cost of oil cake marketing

Research and results of calculations show that on condition of the use of sowing areas (Sáfi) under growing of raw biomaterial and its processing on biofuel the currency funds of the country for purchasing oil or transport fuel would be reduced by 1.5–1.7 milliards of US\$. The use of oil cake and grain stillage (waste) would enable to increase the production of meat and milk to more than 50 milliards of UAH. The state and local budgets would get additionally 10–12 milliards UAH of receipts.

The Table 1 demonstrates the general idea of problems with ecological state in Ukraine presented by total emission in the atmosphere, which in the last few years increased substantially and made over 7 million tons in 2007.

It should be mentioned that energy and transport are main pollutants of the environment (Agro-Industrial..., 2009).

The use of oil products as energy sources is considered ecologically dangerous for population. Hydrocarbons, oxide of nitrogen, carbon oxide, oxide of sulphur, different compounds containing lead, soot and exhaust steam together with exhaust gases are emitted in the air while using mineral fuel. Carbon oxide getting in the organism of a man reduces concentration of oxygen in the blood that is dangerous for people having cardio-vascular diseases. Carbon oxide and hydrocarbons are the source of ozone and constituents of acid rains. Carbon dioxide is the basic constituent of greenhouse gases; surplus emission of latter in the atmosphere is the reason of greenhouse effect and global increase of average annual temperature on the planet.

In 1997 specialists of the Ukrainian Transport University and DerzhavtotransNDIproekt developed technical conditions

and technological regulations on the production of motor petrol with addition of ethyl alcohol. Standard petrol with octane number 76 was utilized as petrol basis, and technical alcohol of the A category, experimental part of which was produced at the Andrusiv Distillery (Vinnytsia region) was used as alcoholic additive. Some components of coke and chemical production were added to stabilize the mixture. Petrol-alcohol composition with octane number 84.0 was obtained by the motor method.

On recommendation of the State Department of Motor Transport of Ukraine, nine cars of different brands participated in the operating tests of petrol with addition of ethyl alcohol. 7 000 litres of experimental mixture were spent.

Fuel-economic and starting peculiarities of cars as well as the content of exhaust gases were estimated during the test drive. Petrol with addition of ethyl alcohol of the A category was stated to be a valuable agile fuel for cars with petrol engines. Its use does not demand any changes in a car's adjusting. The tests demonstrated that an engine on combined fuel emitted carbon oxide (CO) in twice less on the average, hydrocarbons in 1.6 times less in comparison to a standard petrol engine due to more complete combustion of fuel, which is especially important for the cities with complicated ecological situation (Food and processing..., 1997).

The ecological aspect of the use of biofuel produced from rape oil implies a substantial decrease of the emission of carbon oxide by 15–98 %, carbohydrates – by 38–92 %, soot – by 31–68 %, besides the emission of sulphur dioxide is practically absent.

The European countries differ in priorities in the production of biofuel, e.g. France gives the green light to the production of biofuel from corn, wheat, sugar beet; Germany is so far oriented on the production of biofuel from rape seed. Waste of agriculture, food processing and wood industries (straw, corn-stalks, stem, sunflower husk, sawdust, etc) is being utilized now as sources for the biofuel production. Though they are not considered as priorities, they are able to become a rather important raw material source in the future. Wood waste or fast-growing varieties of trees and grass, e.g. selected fast-growing varieties of poplar trees as well as new crops such as silver grass are being used as raw material for producing biofuel (Kaletnik, 2008).

An extraordinarily important factor in the increase of the efficiency of the biofuel production is selection of plants (on the content of useful matters) for producing bioethanol and biodiesel. Modern methods of biotechnology will play a leading role in solving this assignment, namely, the increase of productivity and resistance of plants to abiotic and biotic stresses, the change of biochemical features of grain or other

Table 1 Calculation of competitiveness of bioethanol and biodiesel

	Indices (1)	Years (2)				
		2000	2004	2005	2006	2007
1	Emission of pollutants in the air, thousand of tons (3)	5 909	6 326	6 616	7 028	7 380
2	Emission of carbon, million tons (4)	105	127	152	179	218
3	Contaminated sewage emission to surface water objects in general drainage in % (5)	30	37	39	44	43
4	Waste, placed in special places or objects in % (6)	29.1	45.6	39.3	44.6	38.3

Tabuľka 1 Výpočet konkurencieschopnosti bioetanolu a biodízelu

(1) ukazovatele, (2) roky, (3) emisie škodlivín do vzduchu, tis. ton, (4) emisie uhlíka, mil. ton, (5) emisie kontaminovanej odpadovej vody do objektov povrchovej vody v kanalizácii, %, (6) odpad umiestnený na špeciálnych miestach alebo v špeciálnych objektoch, %

products (content of pentosanes, correlation change of amylose and amylopectin, etc).

It is necessary to underline that fundamental science could contribute to the development of bioenergy through the creation of new genotypes of crops, more adapted to the use of their produce and biomass for the production of biofuel as well as non-traditional crops with increased coefficient of transformation of energy of photosynthesis into necessary biomass at the comparatively insignificant charges of fossil energy for their production, transportation, and storage. Genomics, in particular genetic engineering, and also botany, biochemistry, phytophysiology will play a considerable role in the solution of these tasks.

It will facilitate intensification of research and development concerning alternative renewed energy sources, the use of which must be the priority in the economy of Ukraine.

Results

1. Substitution in Ukraine of mineral fuels by the biological types of fuel (bioethanol and biodiesel) will substantially promote ecological safety and lessen local pollution of the environment.
2. In order to enter new perspective market of consuming ecologically safe renewed energy sources, including bioethanol, biodiesel, different fuel components, biogas and others it is necessary to accelerate the implementation of the following measures:
 - to develop legislatively legal acts concerning the obligatory use of biofuel in Ukraine;
 - to forbid the use of methyltertbutyl ether (MTBE) as extraordinarily strong pollutant of surface and underground waters;
 - to make obligatory norm of consumption of biofuel by transport vehicles in cities with population over 500 thousands of people.
3. Development of production and consumption of biofuel will stabilize activities of the AIC.
4. The biofuel market in Ukraine is a key factor to energy independence and ecologically safe environment of the country.

Súhrn

V danom článku stručne charakterizujeme stav ekológie na Ukrajine a vo svete, ako aj environmentálny dopad emisií z minerálnych a biologických typov palív. Na základe komparácií vyvodzujeme závery, ktoré sa týkajú stavu vývoja bioenergie a jej vplyvu na životné prostredie.

Kľúčové slová: bioenergia, surový biomateriál, biomasa, obnoviteľné zdroje energie, skleníkové plyny, emisie skleníkových plynov

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