

# Formation of state support economic mechanism for solid biofuel producers

*The purpose of the article is to analyze the current state of the solid biofuels market, evaluate functionality and develop an appropriate economic mechanism for its development.*

*Research methodology was based on the general theoretical methods of scientific knowledge, including the fundamental economic principles of the development of energy resources market, highlighted in the works of domestic and foreign scientists. In the research have been used the calculation-analytical and abstract-logical scientific methods, modeling and generalization.*

*Research results of the production and sale of solid biofuels and the prospects for further development have been presented. There have been determined that the current state of the market supply of thermal energy provides rapid transition to alternative fuels, but their production is complicated due to the current economic situation.*

*Elements of scientific novelty. The concept for forming an economic mechanism of stimulation for solid biomass producers has been developed and proposed a formula for determining the volume of financial support (eco-compensation).*

*Practical significance. The importance of introducing state support for producers of alternative fuels at the present stage of socio-economic development of Ukraine has been substantiated. Tabl.: 2. Figs.: 2. Refs.: 12.*

**Keywords:** economic mechanism, bioenergy, biomass, eco-compensation, investment attractiveness, economic efficiency.

Tkachenko Anton Mykolaiovych - research fellow of the department of innovative activities and economics, National Scientific Center "Institute of Agriculture of NAAS" (2-B, Mashynobudivnykiv st., Chabany, Kyievo-Sviatoshyskyi dist., Kyiv reg.)  
Email: tkachenko.a.m@outlook.com

**Scientific problem.** The need to reduce greenhouse gas emissions to the atmosphere while simultaneously covering the total demand for energy became almost the most important global problem in the twenty-first century. Today, the annual CO<sub>2</sub> emissions are about 8 billion tons, and only half of it is absorbed by the ecosystem of our planet. The rest is accumulated in the atmosphere and contributes to the process of global warming. As a result of an increase in the population on Earth and rapid economic growth (especially in developing countries), demand and energy consumption in various sectors of the economy continue to grow rapidly. Such tendencies, together with the reduction of traditional fuels stocks, motivate the search for new, alternative ways of obtaining energy. This problem is especially acute for energy-dependent countries, such as Ukraine.

The use of existing potential for the creation of bioenergy willow plantations would significantly reduce the volume of natural gas imports. In the conditions of the national course on the rapid development of infrastructure for the use of alternative fuels, it is necessary to use modern approaches to develop state support for producers of energy biomass and to assess their economic efficiency.

**Analysis of recent researches and publications.** Fundamental scientific and practical research in the field of alternative fuels, solid biomass energy in particular, and economic efficiency studies were conducted by M. Roik, V. Sinchenko, G. Geletukha, I. Slyusar, and others [3, 8, 9, 10]. However, the issue of state support for producers of energy biomass (at bioenergy plantations) requires further research.

**The objective of the article** - analysis of the economic efficiency of state support for biomass producers by introducing payments in the form of eco-compensations.

**Statement of the main results of the study.** Today, one of the largest consumers of natural gas in our country is the TCE ("Teplocomunenergo", network of state-owned heat supply companies). So, in 2015, in district heating systems of TCE 7.2 billion m<sup>3</sup> of natural gas was consumed, and the amount of produced thermal energy was 67.8 million Gcal [3]. This situation at the heat supply market has arisen as a result of improper stimulation of the alternative fuels usage in the TCE network for many years. Only in March 2017 the Verkhovna Rada of Ukraine first adopted a law that should make the production of heat energy from alternative sources cost-effective [7]. This law radically changes the situation on the heat supply market and will stimulate the development and

expansion of heat-generating facilities (Heat-only biomass boiler stations). However, the document does not take into account the interests of the biomass producers, as fuel suppliers for these stations. In the media and the Internet are often found ambitious plans of foreign and domestic investors to develop Ukrainian bioenergy, but, at the moment, it may be possible that modern biomass boilers will be built, but the biomass itself will not be on the market, because its production is not economically efficient. In previous studies, we found that DPP (discounted payback period) of the bioenergy willow plantation projects is more than 19 years [9]. That is why the issue of introducing a state aid mechanism for such projects is so relevant.

As financial support at the initial stage of creation of environmentally friendly fuel, it is proposed to stimulate biomass producers in the form of compensation and introduce the term "eco-compensation".

*Eco-compensation* - is a monetary payment that is proposed to be provided to the company that created the bioenergy plantation and received the first crop of biomass. Such compensation is available only for the first cycle of growing bioenergy crops. Amount calculated according to the formula:

$$ECO = \frac{P_{tr} \times Q_{eco}}{Q_{tr}} - P_{eco}$$

$Q_{tr}$  - calorific value of traditional fuel (for natural gas - 8300 kcal/m<sup>3</sup>, as the average for the last 10 years in Ukraine according to NJSC "Naftogaz of Ukraine") [12].

$Q_{eco}$  - calorific value of sold ecologically safe alternative fuel. For biomass in the form of wood is determined by the Nadezhdin formula:

$$Q_{eco} = Q_{hvh} - 50 \times W$$

$Q_{hvh}$  - higher heating value of sold biomass (for willow - 4500 kcal/kg, according to the data of Food and Agriculture Organization of the United Nations) [2].

$W$  - the percentage of moisture content of the sold biomass.

$P_{tr}$  - the actual cost of traditional fuel (natural gas) in Ukraine at the time of the biomass selling.

$P_{eco}$  - cost of environmentally friendly alternative fuel (biomass).

The feasibility of eco-compensation is explained by the eco-modern policy of import substitution for the traditional energy resources in Ukraine. The government should be interested in supporting the domestic producer of an alternative type of biofuel in an amount that is at least directly proportional to the cost of the replaced energy resource (Figure 1).

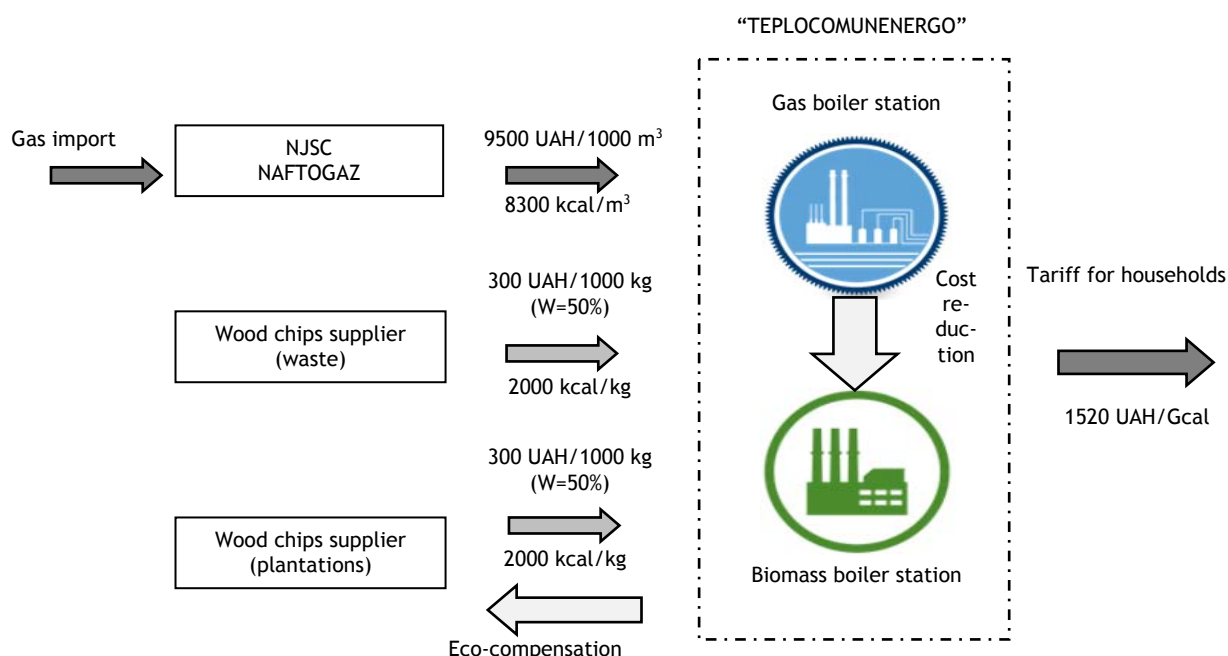


Figure 1. Modern model of heat energy supply to the consumer, taking into account eco-compensation

Source: author's own development using [1, 6, 7].

Today, in the modern scheme of thermal energy supply, biomass, obtained by plantation method, has the same value as wood industry waste, and this in turn affects the pricing. Proposed incentive mechanism allows to compensate the low cost of biofuel in accordance with its energy value. Such an approach to stimulate biofuel producers is effective at the expense of the fact that the consumer of biomass (TCE company) does not incur additional costs, but only one time returns the difference in the cost of gigacalorie (GCal) to the producer. Subsequently, the following harvest of biomass from this plantation will provide it with fuel at a market price for at least 19 years.

The effectiveness of the proposed mechanism was calculated and modeled on the example of Panfily Research Station of NSC «Institute of Agriculture NAAS» and heat-only boiler station of "Kyiv-Svyatoshin heating network" (running on natural gas).

Panfily Research Station is located at: Kyiv region, Yagotin district, Panfily village. The farm has about 200 hectares of drainable peatlands, which are suitable for creation of bioenergy plantations using the technology of NSC "Institute of Agriculture NAAS". The elements of the technology were studied at the test sites and used for creation of the plantation with an area of 2 hectares.

The calculation of the investment return terms for the project of plantation creation of the bioenergy willow *Salix triandra* L was conducted taking into account the following basic indicators:

- Yield for 3rd year of vegetation - 70 t/ha (Panfils'ka variety)
- Rental fee for planting machinery - 5000 UAH/ha (according to the price of Salix Energy LLC, June 2017)
- Rental fee for harvesting machinery - 8000 UAH/ha (according to the price of Salix Energy LLC, June 2017)

- The cost of fuel - 22 UAH/liter (average price for diesel fuel in Ukraine in 2017 according to the financial portal - minfin.com.ua)

- The cost of planting material - 0,5 UAH/piece (according to the price of Panfily Research Station, June 2017)

- Wages - 35 UAH/hour (the average hourly payment in agriculture according to the State Statistics Service for the period from the beginning of the year in 2017)

- The cost of biomass - 300 UAH/t (average price for wood chips with a humidity of 50% according to the largest online trading platforms Prom.ua, Olx.ua та All.biz, May 2017)

- The price of natural gas - 9500 UAH/1000m<sup>3</sup> (according to the price list for natural gas from May 1, 2017 - according to NJSC "Naftogaz of Ukraine")

- Credit rate - 14,3% (in accordance with the indicators of monetary and financial statistics of the NBU in April 2017 in national currency for the corporate sector)

In the calculations of investment attractiveness was used the discount rate  $r = 22,4\%$ .

$$r = r_f + r_s + r_v,$$

$r_f = 9,1\%$ . Risk-free rate of return, calculated as the interest rate of deposits in April 2017 in national currency, according to the National Bank of Ukraine [5].

$r_s = 10,0\%$ . Percentage for the systematic risk of investing in Ukraine (the country's risk level), according to foreign investors.

$r_v = 3,3\%$ . Risk percentage, characteristic for agriculture.

Taking into account the results of calculations, it can be stated that, in modern realities of the Ukrainian economy, investing in bioenergy plantations is completely unprofitable (Table 1). The reason is the extremely high rate of discounting, which, in turn, reflects the state of our economy as a whole.

Table 1

### The economic efficiency of the investment project of bioenergy plantation creation with an area of 10 hectares

Indicator	Financing scheme		
	Own investments	Own investments + eco-compensation	Credit funds + eco-compensation
NPV - Net Presented Value, UAH	-334299	508914	252383
IRR - Internal Rate of Refund, %	8,5	50,2	32,1
PP - Payback Period, years	7,2	3,1	4,1
DPP - Discounted Payback Period, years	>19	3,62	4,41
PI - Profitability Index	0,41	2,41	1,41

Source: author's own calculations. Exchange rate: 1 USD = 25 UAH.

The proposed mechanism of eco-compensation for biomass producers makes the project attractive even under such economic conditions. The period of investment

return (both own and credit funds) is 3 or 4 years, respectively, that allows to call such investments economically feasible for investors (Figure 2).

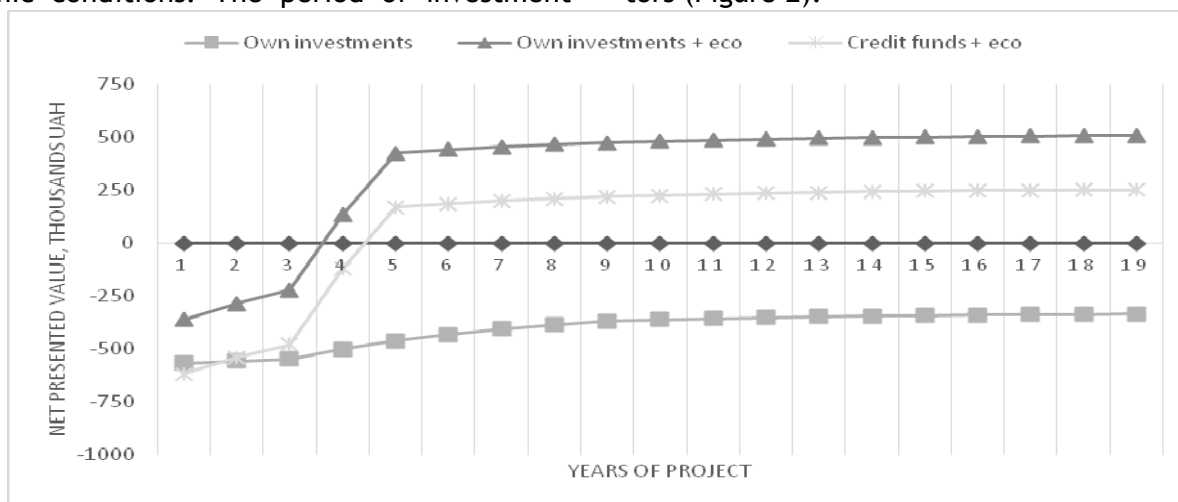


Figure 2. Net Presented Value of investment project of bioenergy plantation creation with an area of 10 hectares, under different financing schemes

\*Source: author's own calculations.

Plant origin biomass making up to 50% in the structure of renewable energy sources in the world and more than 15% of the total energy consumption [4, 8]. At the same time, the current state of development of biofuel production in Ukraine is in the stage of formation and accounts for about 1% of the total energy consumption. Among the wide range of problems in this industry with legislative and regulatory acts, the lack of harmonized European standards for raw materials, biofuel producers also face the problem of supply shortage for stable operation of enterprises throughout the year.

For example, the needs of the town Chabany (Kyiv-Svyatoshinsky district, Kyiv oblast) in heat energy are currently provided by a single natural gas boiler station which produce 9448,6 Gcal per year. The heat energy tariff for the households is 1520 UAH/Gcal (the fuel component in the tariff is 984 UAH/Gcal) [11]. In the developed investment project for local

authorities it is proposed to use, in order to reduce the cost of heat energy, high-efficient biomass boilers. For the production of heat energy, it is planned to install two “KBМ(a)-0,82” boilers (KRIGER, Ukraine). Proposed equipment provides total thermal power up to 1,6 MW/hour, which will allow to produce up to 4363 Gcal per season and thereby reduce the need in natural gas by 46%.

However, to ensure optimal operation of such equipment, 2129 tons/year of biomass need to be provided in the form of wood chips ( $Q=2440$  kcal/kg). An analysis of wood chips suppliers near town Chabany has shown that stable supply of such amount of fuel from local producers (at a price of 300 UAH/t) is quite difficult due to its market deficit. The cost of delivering from neighboring regions increases in direct proportion to distance and the price of fuel can reach 1500 UAH/t. At such price, investment attractiveness indicators of the project are significantly reduced (Table 2).

Table 2

Financial indicators of the project: substitution of natural gas at Chabany boiler station

Efficiency indicators	Wood chips price		
	300 UAH/t	1500 UAH/t	300 UAH/t + eco-compensation
NPV - Net Presented Value, UAH	16327	3919	8123
IRR - Internal Rate of Refund, %	56,1	28,4	31,5
PP - Payback Period, years	1,78	3,43	3,78
DPP - Discounted Payback Period, years	2,39	6,11	5,78
PI - Profitability Index	2,73	1,41	1,86
Discount rate, %	19,1		
Eco-compensation, UAH/t	2493		

Source: author's own calculations. Exchange rate: 1 USD = 25 UAH.

In the absence of the possibility to make stable supply of large quantities of cheap raw materials from local wood processing enterprises, stimulation of biomass production at bioenergy plantations, by eco-compensation implementation, becomes an investment attractive alternative. An additional advantage of such state support is the economic development of its own region as a result of the bioenergy market growth.

Similar projects of heat supply system renovation are the basis for the the development of whole communal infrastructure. That is why it is important to attract investors in modernization and development of heat-supply systems of housing and communal services. It is necessary to start with the introduction of a mechanism to support local biomass producers, which will allow to create sustainable fuel source for the needs of the heat-generating objects of the town.

The conducted analysis shows, that one of the main reasons for low use of solid biomass

at TCE enterprises is its deficit at the local level and, consequently, higher logistics costs to ensure stable supply. This, in turn, is due to the low investment attractiveness of biomass production projects. That is why the mutually beneficial mechanism of state support is so relevant.

**Conclusions.** The government, at the level of local authorities, should be interested in supporting of the domestic producer of an alternative fuel. The implementation of eco-compensation mechanism will allow biomass producers to reduce their maintenance costs and significantly reduce payback period. Production of biomass for energy needs will be attractive for investment. Such support will stimulate the rapid development of the bioenergy market and will ensure the fuel diversification in regions. Legislative and economic mechanisms for regulation of eco-compensation payments should be the subject of further research.

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#### **Ткаченко А.М. Формування економічного механізму державного стимулювання виробників твердого біопалива**

**Мета статті** - проаналізувати сучасний стан ринку твердого біопалива, оцінити функціональність і формування відповідного економічного механізму його розвитку.

**Методика дослідження.** Використано загальнотеоретичні методи наукового пізнання, включаючи фундаментальні положення й принципи розвитку ринку енергетичних ресурсів, висвітлені у працях вітчизняні і зарубіжних учених, а також такі методи, як розрахунково-аналітичний, абстрактно-логічний, моделювання та узагальнення.

**Результати дослідження.** Проаналізовано процеси виробництва й реалізації твердого біопалива і перспективи його розвитку. Визначено, що сучасний стан ринку постачання теплової енергії передбачає стрімкий перехід на альтернативні види палива, проте їх виробництво ускладнено через поточну економічну ситуацію.

**Елементи наукової новизни.** Розроблено концепцію формування економічного механізму стимулювання виробників твердої біомаси та запропоновано формулу для визначення обсягів фінансової допомоги (екокомпенсації).

**Практична значущість.** Обґрунтовано важливість державної підтримки виробників альтернативних видів палива на сучасному етапі соціально-економічного розвитку України. Табл.: 2. Рис.: 2. Бібліогр.: 12.

**Ключові слова:** економічний механізм, біоенергетика, біомаса, екокомпенсація, інвестиційна привабливість, економічна ефективність.

Ткаченко Антон Миколайович - науковий співробітник відділу інноваційної діяльності та економіки, Національний науковий центр «Інститут землеробства НААН» (сmt Чабани, вул. Машинобудівників 2-Б)  
E-mail: [tkachenko.a.m@outlook.com](mailto:tkachenko.a.m@outlook.com)

#### **Ткаченко А.Н. Формирование экономического механизма государственного стимулирования производителей твердого биотоплива**

**Цель статьи** - проанализировать современное состояние рынка твердого биотоплива, оценить функциональность и формирование соответствующего экономического механизма его развития.

**Методика исследования.** Используются общетеоретические методы научного познания, включая фундаментальные положения и принципы развития рынка энергетических ресурсов, освещенные в работах отечественных и зарубежных ученых, а также такие методы, как расчетно-аналитический, абстрактно-логический, моделирования и обобщения.

**Результаты исследования.** Проанализированы процессы производства и реализации твердого биотоплива, а также перспективы его развития. Определено, что современное состояние на рынке поставок тепловой энергии предусматривает стремительный переход на альтернативные виды топлива, однако их производство затруднено в связи с текущей экономической ситуацией.

**Элементы научной новизны.** Разработана концепция формирования экономического механизма стимулирования производителей твердой биомассы и предложена формула для определения объемов финансовой помощи (экокомпенсации).

**Практическая значимость.** Обоснована важность государственной поддержки производителей альтернативных видов топлива на современном этапе социально-экономического развития Украины. Табл.: 2. Илл.: 2. Библиогр.: 12.

**Ключевые слова:** экономический механизм, биоэнергетика, биомасса, экокомпенсация, инвестиционная привлекательность, экономическая эффективность.

Ткаченко Антон Николаевич - научный сотрудник отдела инновационной деятельности и экономики, Национальный научный центр «Институт земледелия НААН» (пгт Чабаны, ул. Машиностроителей 2-Б)  
E-mail: [tkachenko.a.m@outlook.com](mailto:tkachenko.a.m@outlook.com)

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